THE

ELECTRICAL REVIEW.

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ACETYLENE.

IT is announced in a contemporary that "a most important step towards lighting by acetylene gas is now in contemplation, and that within a few weeks the manufacture of this gas will be undertaken on a commercial basis." It appears that Mr. Sampson Fox (of water-gas fame) has been instrumental in the formation of a small company for acquiring certain patents for the electric production of calcic carbide, from which, as is well known, acetylene gas can be produced by the action of water. Mr. Willson, the inventor, who secured the said patents, states that he has brought the process of the production of carbide of calcium to such perfection that acetylene gas of 25 candle-power can be made at a cost of 10d. per 1,000 cubic feet.

Inventors are proverbially sanguine, and before the investing public should look at such an enterprise, it is advisable they should know whether or not the evidence of independent experts confirms the sanguine statements of the inventor. In examining such a case as this, we must look chiefly to the questions of priority of invention, as having an important bearing on the validity of the patents, and the superiority, as regards cost and general amenities, of the new over the old methods of illumination.

As regards priority, an article by M. Moissan, a pioneer in research with the electric furnace, published in the *Révue Générale des Sciences* of June 20th last, has an important bearing. M. Moissan states that Mr. Willson's first publication in which he refers to his experiments with the electric furnace, was in a patent taken out in America of the date February 21st, 1893, entitled "Electric reduction of Refractory Metallic Compounds." M. Moissan's first research in an electric reverberatory furnace, with movable electrodes, was published in the *Comptes Rendus* on December 12th, 1892. The note relates to the reduction by carbon of certain metallic oxides, but the accidental formation of calcium carbide by the action of the vapours of calcium upon the carbon electrodes is also cited. Mr. Willson states in his patent just cited, that he has already employed his invention for the reduction of oxide of calcium and the production of carbide of calcium, but adds that sufficient carbon should be added to prevent the formation of a molten bath, a prescription which Moissan contends invalidates his invention, because the formation of calcic carbide in the electric furnace is not an electrolytic process, but purely a process of fusion. Mr. Willson appears, himself, to have made this discovery before he applied for his German patent in June, 1895, where he states that the formation of calcic carbide in the electric furnace should be considered as a simple process of fusion. This change of opinion on the part of Mr. Willson between the dates of his two patents,

M. Moissan considers was due to the publication by himself of a note in March, 1892, in which he gave the results of a complete study of the preparation, physical properties, and chemical composition of calcium carbide. M. Moissan concludes with the exhortation: "Science does not content itself with an assertion; it asks for proof. It is not sufficient to say: 'I have obtained such or such a body;' it is necessary to give the method of preparation, the analysis of the products obtained, their formulæ of constitution, and their properties. It is this which Mr. Willson, in his patent, has failed to do."

Several different estimates have been given of the cost of calcic carbide produced in the electric furnace. Prof. V. B. Lewes, in his lecture before the Society of Arts, puts it at £4 a ton. The Electric Gas Light Company, the manufacturers in America of the present stock of calcium carbide, estimate the cost as £3 a ton; Mr. M. P. Woods, in the *American Gas Light Journal*, estimates the price at over £4 a ton when produced at Niagara, where it is proposed to supply a kilowatt hour at ½d., and at over £5 a ton, with coal at £3 a ton. These latter estimates are costs at the factory, and therefore considerably less than prices on delivery. All these estimates are also merely on paper, a quotation from the manufacturer to a correspondent which we have already quoted more than once, amounts to ten times the highest of the paper estimates. The final result, if the substance was manufactured in large quantities, would, no doubt, be somewhere between these extremes.

The important question comes to be, at what price acetylene can compete with the materials it is intended to replace. It appears to be out of the question to use acetylene in the pure form as an illuminant. In this condition the gas is poisonous, and therefore not adapted for domestic lighting; it also is capable, under favourable conditions, of forming explosive compounds with brass and copper pipes, so that such gas fittings as at present in use would have to be dispensed with. The only practicable way to use the gas for house illumination appears to be to mix it with air, or to use it as an enricher of poor coal gas. It is by some such method as this, we presume, that Mr. Willson proposes to produce his gas at 10d. per 1,000 cubic feet. In this process acetylene will have to compete with such substitutes as naphtha gas, 5 gallons of which, at 1d. to 2d. per gallon, is required to enrich 1,000 cubic feet of gas. To compete successfully with this, acetylene will have to be produced at £3 a ton, the lowest estimate cited above.

The system of supplying gas mixed with air for illuminating purposes appears, from the nature of the case, to be a particularly dangerous one. Acetylene mixed with 1·25 times its volume of air is slightly explosive, with 12 volumes of air its explosive violence is a maximum, with 20 volumes of air it ceases to be explosive. Any accidental disturbance of the safe proportions of the mixture might lead to a serious explosion, and it would require a great deal of assurance to convince a consumer that no such disturbance can possibly occur.

To sum up, we do not think, in view of M. Moissan's statement, that Mr. Willson can establish priority to a wide claim for the production of calcic carbide in the electric furnace. Moreover, the cost of the acetylene produced in this way does not appear to promise any great economies over other processes in use for the same purpose, and, besides, the objectionable odour, the poisonous properties, and the dangerous corrosive action of the gas on brass fittings, appear to bar its use for domestic lighting.

THE INTERNATIONAL ELECTRIC STORAGE BATTERY.

During the past 10 years, there have been at various times great outbursts of enthusiasm, chiefly in papers which have been read before the Tramways Institute, over various secondary batteries, which, from the point of view of the papers, or communications of the authors, appear to have reached the acme of perfection generally, and more especially in so far as they relate to the application of the respective particular type of battery to motive power purposes.

Notwithstanding the great improvements and merits which have on paper been claimed for these various storage cells, it is, as far as we are aware, a fact that the E.P.S. cells, which, with some modifications in mechanical detail, are the same (at least in general design of plate) as those in use in 1887 and 1888, are still doing much the larger portion of the work, not only in those cases where electric traction by accumulators is at present in use in this country, and in general launch work on the rivers and inland waters of the United Kingdom, but also for general storage battery work in central supply stations and private installations, and it is no disparagement to the few other well known and excellent types to say so.

It is a well known fact to all who have experience in accumulators, and the management of the E.P.S. Company must have been aware of it for some considerable time, that by slight modification of their present patterns, cells can be made having a much larger capacity with less weight than those which they at present put on the market; and it seems at least reasonable that if it had been found that such cells could be relied on to compete in lasting powers with those at present in use, the E.P.S. Company would have adopted such alteration.

Coming now to the statements made in the paper read a few days ago at the Tramway Institute by Mr. A. G. New on the I.E.S. cell, and published in our last issue, it would certainly seem to be as well that the author qualifies the remarks that he makes in the paragraph in which he states that the "I.E.S. plates fulfil, as far as possible, the conditions required for traction work," by inserting "with the present amount of practical experience." We should be inclined to ask, what is the amount of practical experience existing, and who has it?

We are further inclined to ask Mr. New, or the I.E.S. Company, how a plate covered with perforated celluloid, by which at least half the active surfaces must remain inaccessible to the electrolyte, can satisfy the condition under heading II. of the paper, in which he says that "the active material should offer as large a surface to the electrolyte as possible." We notice that the writer remarks, "the capacity of the I.E.S. plate has been shown by experiment to be three to five times that of the E.P.S. plate of the same size and surface." This appears to us to be a very loose way of wording a comparison. In the first place, are we to understand that by the word "size," the thickness of the plate is

also included; how many discharges on one set of plates were made which produced this result, and where have the figures been published which prove this?

The writer of the paper under notice proceeds to say:—"It (the I.E.S. cell) is, moreover, capable of standing heavy charges and discharges to an extent that would soon destroy an E.P.S. plate." This, too, is difficult of proof without figures, besides being exceedingly vague; and, so far as we are aware, quite contrary to the experience of any with whom we have come in contact, who have any large practice in secondary battery work. The generally accepted principle is, that a plate to stand heavy discharges must have a large amount of conductor, in order to ensure that the chemical action may go on uniformly throughout the mass of the active material.

With reference to the succeeding paragraph of the author's paper, we feel inclined to add that, whatever dealings he may have had with the I.E.S. cells, he certainly does not appear to have had any practical experience with E.P.S. cells, or he would not have made the remarks with reference to "plugs of paste being jerked out." We believe that little or no trouble is now found with E.P.S. cells from this cause, and it remains to be seen whether the gradual disintegration of the active material of the new cells is any less than, with equal current density, is experienced with other forms.

A Curious Case of Deposition.

There is, unfortunately, such a thing as professional bias, and this phenomenon manifests itself in divers ways. It is particularly rampant in regard to what may be termed mental attitudes, and chiefly because we err in these days on the side of over-specialisation. We specialise because commercialism teaches us that "it pays," but one of the penalties is that we often regard things with a too limited vision. Illustrations of this occur very thickly in all electro-chemical matters; and one reason why there is so much chaos in this borderland between physics and chemistry is because those who are exploring it are not in sufficient accord. The chemist persists in endeavouring to explain phenomena from the strictly chemical standpoint, and the physicist from the purely physical standpoint. The truth usually lies halfway between any two given extremes. But it is the chemist who, perhaps, has erred most in this direction, hence we commend the following experience to his reflection. In the *Bulletin de la Société Chimique de Paris*, xi. [24], pp. 1,163, 1,164, there is a paper by J. B. Senderens, in which he describes the following phenomenon:—A bar of lead was placed in a neutral solution of lead nitrate at the ordinary temperature of the atmosphere. It was found in course of time that particles of metallic lead were deposited on the surface of the bar, whilst a coating was also formed of basic nitrates and nitrosonitrates of lead. "A purely chemical phenomenon!" says the chemist, who at once proceeds to devise apalling equations, which in his opinion expresses the operations in a concrete form. However, a careful investigation showed that this deposition was due to the different physical conditions of the outer skin and the main portion of the bar of lead, and the production of a galvanic current between the crystalline lead in the interior of the bar, and the smooth-tempered outer layer. Senderens succeeded in showing that if a *portion* of the bar is used the action is much more rapid, owing to the two elements of the couple coming more freely in contact with the solution.

The Sp. Ind. Capacity of Water, &c.

Experimental investigation in these days has been so far removed from empiricism, and has approached so closely to mathematical accuracy, that we are apt to pride ourselves on our results, and to accept data as constant and unmodifiable which a few years ago we might possibly have questioned. Therein consists a danger and a weakness. Absolute accuracy is not attainable, and we can only hope for close approximations. Hence it is desirable to review many sets of data upon which we have been accustomed to base our formulæ as well as our faith. In illustration of this it is only necessary to refer to the high values hitherto accepted with implicit confidence, for the specific inductive capacity of such liquids as water and alcohol. Yet if we regard these values as unalterable, Maxwell's rule for the relation between specific inductive capacity and the index of refraction must necessarily be abandoned. With all our boasted accuracy of thought, we are too ready to gloss over such want of accord as is evidenced in the illustration referred to. That this is unscientific and unworthy of these latter days of enlightenment, is perfectly obvious the moment we pause. We have endeavoured to patch up the discrepancy by calling to our aid the phenomena of dispersion, &c. We had far better overhaul the numerical data which are at the root of the whole matter. Hence we are glad to recognise a useful scepticist in R. A. Fessenden, who claims that the high values hitherto accepted for the specific inductive capacities of water, alcohol, &c., are incorrect. He has been reinvestigating these values, and his own results, which naturally he believes to be the true ones, are very nearly equal to those called for by Maxwell's theory. He is of opinion that the cause of the errors which have brought out high values in the researches of previous investigators lies in the fact that electrolysis gives a capacity effect. It is for this reason, he argues, that Kohlrausch's method almost always gives erroneous results, even in the hands of skilled experimentalists; for what is really measured is not the resistance of the electrolyte, but its *impedance*. For further details consult the *Philosophical Magazine* [5], xxxviii., pp. 567, 568.

Electrical Potentials.

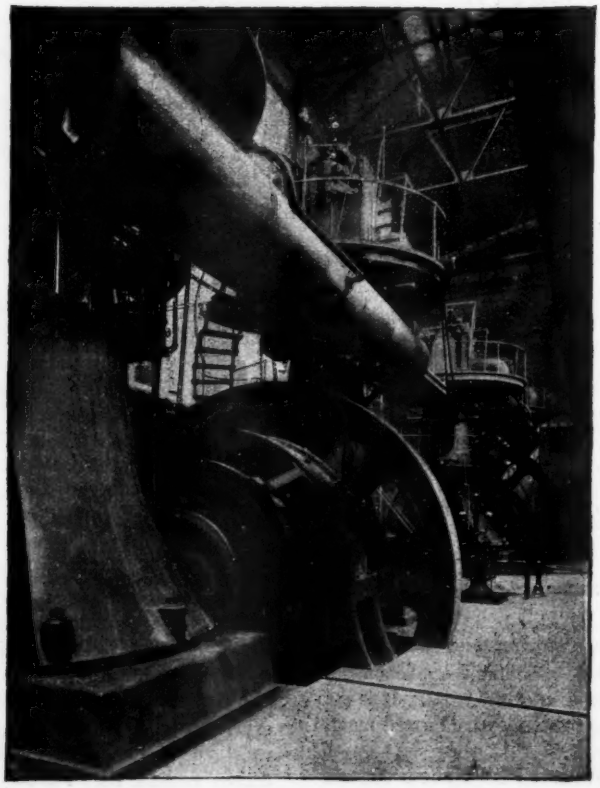
The phenomena of electrical potentials in a liquid conductor in uniform movement have recently been the subject of an investigation by G. de Villemontée, who describes the results of his researches in the *Comptes Rendus*, cxix., pp. 1,201, 1,202. The solutions placed under experiment were those of the sulphates of zinc, copper and nickel, the strength being 10 grammes of the salt per litre. Mercury was also included in the observations. The liquids were mounted in glass tubes of uniform calibre, supported either vertically or horizontally. These tubes were insulated. The liquids were then caused to move through the tubes at a uniform rate. The object of the observations was to detect, if possible, differences of potential between any two given *loci* in the liquids. A capillary electrometer, capable of indicating 0·00015 volt, was used to facilitate the work, and the electrodes consisted of platinum wires, the ends of which were tipped with an electrolytic deposit of the metal contained in the solution under examination. The rates of movement, and the diameters of the tubes through which the liquid passed, were of course ascertained. De Villemontée records a large number of observations, and from a critical inspection of them, he concludes that the uniform movement of a liquid conductor through such tubes as he used in his experiments produces no difference of potential, capable of being recognised by the delicate electrometer employed, between two selected points in the liquid. The limits of velocity were for the horizontal tubes 33·5 mm. per second, and for the vertical tubes 155·3 to 323 mm. per second.

THE CHICAGO ELEVATED RAILWAY.

If we do not often beat Americans in being first with electrical projects, we can claim that the Liverpool Overhead Railway will have a marked influence on the elevated railroads of the United States. An elevated railway is quite an American institution; so foreign is it to English practice, that we believe the construction and the subsequent success of the Liverpool Overhead Railway had far more interest to American engineers than to English. At the same time although elevated railways may never be generally adopted in this country, some account of what our friends are doing across the water in this particular branch of railway engineering cannot fail to be of interest. The new elevated railroad of Chicago is said to be the finest elevated railway in the world, and constitutes, perhaps, the widest application of electricity yet made in railroad practice.

For much of the following information as well as illustrations, we are indebted to the columns of the *Street Railway Review* and the New York *Electrical Engineer*.

One curious feature about this scheme, though not unexampled, is, that much of the capital necessary for the undertaking has been raised in London. We are not going to draw comparisons between this fact and the one furnished by an electric railway in London, which was unable to proceed with its project because sufficient money was not forthcoming. We can, however, congratulate American railroad men upon convincing English financiers that there is something in electric traction; we may yet hope that these same financiers may look kindly upon electric traction even when proposed in this country.



Power House.

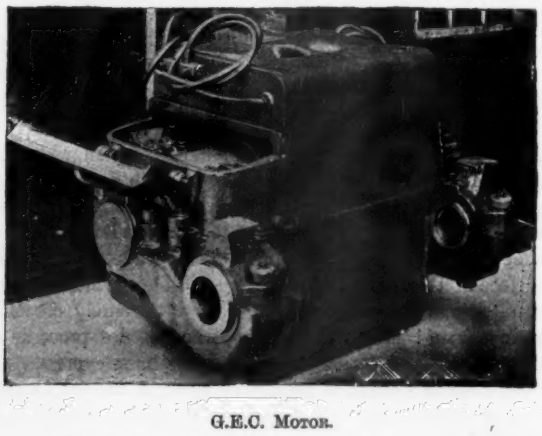
The Chicago Elevated Railway, which will be shortly opened through its entire length to the public, will consist of 18 miles of road. Tracks are laid for express trains, which will pass from the centre of Chicago into the suburbs in 5 minutes. Originally, the railway was designed for steam, but a consideration of the figures shown by the intramural railway at the World's Fair resulted in the adoption of electricity.

The structure is one of the heaviest ever built. It was designed to carry safely 30-ton locomotives, followed by double-deck cars. The minimum height of the structure above the street is 14 feet, the usual height being 15 feet. The track is 4 feet 9 inches above the bottom of the supporting girders. The supporting pillars are 14½ to 18½ feet high. The standard foundation is 7 feet deep and 8 feet square. The girders are 4 feet deep. Distance between pillars is 39 to 50 feet. The lateral bracing is equivalent to 450 lbs. per lineal foot of track. At boulevard crossings a special ornamental form of structure is employed.

The most notable of the structures is the rolling lift or jack knife bridge across the Chicago river, which is shown in one of the illustrations. The bridge spans 174 feet from pier to pier. It is really two distinct bridges, each bridge having two tracks. The two parts are raised and lowered separately. The west halves are operated from an elevated tower between the tracks, and the east halves from the switch and signal tower south of the tracks. The motors, controllers, and air brakes for raising and lowering the bridges are practically identical with the motor car equipments described later. The longest of the viaducts spans a clear space of 254 feet.

The power station is 300 feet long, 90 feet wide, and 78 feet high. Its present capacity is 6,000 H.P., but should the service demand an increase, this capacity could be readily doubled, by extending it to take in the site of the

General View of Track.



G.E.C. Motor.

municipal lighting plant which has become the property of the company.

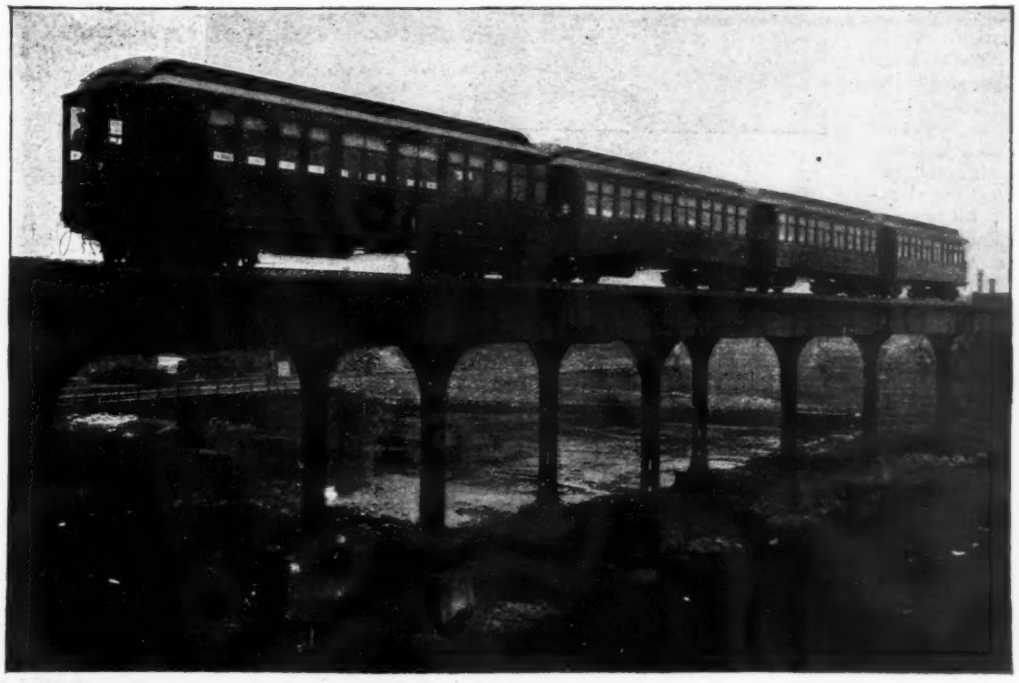
The engines are of the compound inverted vertical direct acting Corliss type, constructed by the Allis Company, of Milwaukee. Four of these are already set up in place on solid brick and concrete foundations. Two are of 2,000 H.P. each and two of 1,000 H.P. each. The cylinders of the larger engines measure 36 and 72 × 48 inches stroke, those of the smaller 23 and 43 × 48 inches stroke. The diameter of the shaft in the larger engine is 24 inches; it carries a 70-ton fly-wheel, 24 feet in diameter, with a rim 21 × 20 inches, making 75 revolutions per minute. The fly-wheel in the smaller engines weighs 35 tons, is 17 × 17 inches at the rim, 18 feet in diameter, and makes 100 revolutions per minute. Easy access is gained by the galleries to all parts of the engines. Each pair of engines is fitted with two distinct governors, one controlling the point of cut-off, the other connected with a safety valve in the main steam pipe. This is closed the instant the speed exceeds a certain number of revolutions.

The boilers are 12 in number, and come from the works of the Babcock & Wilcox Company. Each boiler has a capacity of 300 H.P., and is provided with a Babcock and Wilcox mechanical stoker. They are divided into six batteries of two boilers each, and are designed for a working pressure of 165 lbs. The furnaces are provided with smoke consuming devices, which work, so far, satisfactorily.

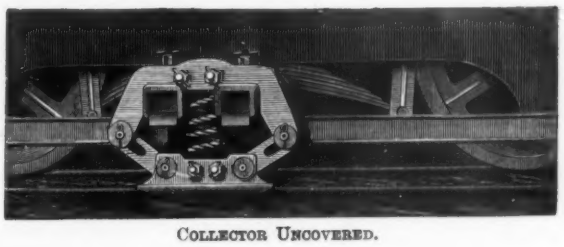
The entire electrical equipment, generators, motors, and accessories, was furnished by the General Electric Company. The generating plant consists at present of two 1,500 kilowatt generators similar to those now operating the Brooklyn City Railroad, of Brooklyn, and the People's Traction Railroad, of Philadelphia; and two 800 kilowatt generators similar to those in the railway power station at Buffalo and at St. Louis.

The machines are set up in place between the high and low pressure sides of the engine, and are thus enclosed by the engine frames.

From the generators the current is led over insulated copper cables to the switchboards, which are built up of General Electric standard generator and feeder panels. Each of the former is equipped with the necessary field rheostat, lightning arrester, voltmeter plug switch, and positive and negative main switches, both single pole. In addition, it carries a Weston illuminated dial ammeter, and an automatic circuit breaker, which breaks the generator circuit instantly should a dangerous overload be thrown upon the machine by accident. The equalising switch is mounted on a pedestal near the generator, and the length of the equaliser is thus reduced. The field rheostat and lightning arrester are set at the back of the board, the former being operated from the face by a hand wheel. A discharge resistance is attached to the field rheostat to cushion the discharge when the field switch is opened. It is connected in series with a pilot lamp in front of the panel. The lightning arrester consists of an iron clad electro-magnet, in the field of which are two carbon points separated by a $\frac{1}{32}$nd inch air gap. The points are connected between the generator lead and ground; the magnet, between the generator and line, the induction of its windings affording additional protection to the generators against lightning. The lighting switch is single pole and quick break, and is connected to the negative terminal main switch. The positive side of the lighting circuit is connected through a magnetic cut-out to the equalising bus. Current can therefore be supplied for lighting purposes from any generator, whether its circuit breaker or main switch is open or closed. The voltmeter is a Weston illuminated-dial instrument, which is connected by the insertion of a plug in the four point receptacle in front of the board, two of the points of which are connected to the generator between it and the main switch, the other two to the voltmeter bus bars.



Train on Line.



Collector Uncovered.

The feeder switchboard is divided into a separate panel for each feeder.

From the station the current is conducted by heavy feeder cables to the lateral third rail used as a working conductor which is shown in the view of the track. This

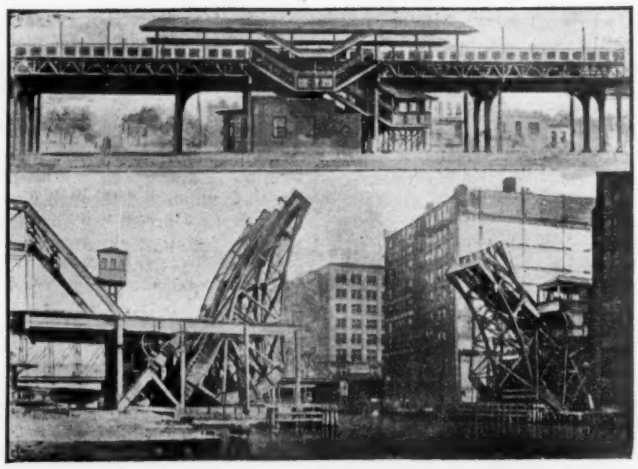
rail is fastened to heavy timber beams set outside the guard timbers of the regular track. The top of the rail is elevated somewhat above that of the service rails, which are used for the return, and are carefully bonded by two copper strips, one on each side, of extra large cross section riveted cold through the holes in the web. Fifty-five motor cars and 100 trailers will make up the rolling stock of the road at its opening.

The motors are known as G.E. 2,000, a title explained by the power of the motor, which is rated at 2,000 lbs. horizontal drawbar pull through a 33-inch wheel at 20 miles an hour. The rated capacity in horse-power is 100 H.P. under normal conditions, and 150 H.P. for short intervals. The maximum speed is rated at between 35 and 40 miles an hour on straight and level track.

These motors, one of which is illustrated, are of the single reduction type, 33 inches high and 50 inches wide over gears. The field frame is of steel, and the armature of the iron-clad type, with series drum single turn barrel winding, these windings being set in slots in the outer surface of the core. The motor is thus rendered mechanically staunch and easy of repair. The insulation both in the armature and field is of asbestos and mica, thus making the deterioration of the insulation from heating impossible. It is entirely enclosed, and is dust and water-proof. Two doors at the commutator end allow of access to the interior, and the motor can be readily inspected either from above or below. Two of these motors are mounted upon one of the two trucks of the motor cars, one to each axle.

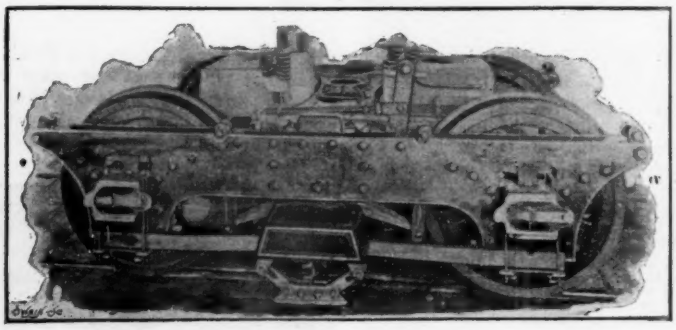
In addition to the motors each car is equipped with two series-parallel controllers especially designed for this work, and two electric air compressors for the air brakes. The motors are protected by an automatic main switch which is in this case a "K" automatic circuit-breaker. In the operation of the controller, when a quick start is desired, the handle is brought round one half a turn to the right, thus bringing the motors into multiple at full speed. If the start is to be the ordinary gradual acceleration, the handle is moved half a turn to the left, and the motors brought up to half speed; another turn in the same direction throws them in multiple, and they move forward at full speed. The arrangement is such that each motor takes an equal portion of the load; and this is, perhaps, one of the most important factors in traction work.

The reversing switch which is arranged at the side of the controller, and is capable of movement from and toward the motor-man, is equipped with a safety interlocking device. This operates to render the reversal of the motors impossible, should the controller handle not be in the right position. As in the "K" controller, this one is equipped throughout with the G. E. magnetic blow-out.



Views of Station and Rolling Lift Bridge.

The Railway in Course of Construction.



Motor Truck Showing Collector Covered.

Current is taken from the third rail by a contact shoe (illustrated), which hangs from an open beam projecting from the side of the truck. The shoe is suspended by means of links, which allow of its accommodating itself to any unevenness of the rail or track. Each motor truck is equipped with two of these, one on either side. Going north the right shoe is in contact, going south the left shoe. The road has no loops at the terminals.

Each motor car is provided with two motorman's compartments built out upon the platforms, set diagonally at the opposite ends. Each compartment contains its own controller and pump.

The trains will consist, at first, of one motor car, fitted up as a smoking car, and three trailers. Each motor car, fully loaded and equipped, will weigh 63,500 lbs., each trailer car loaded 46,000 lbs. With the two motor cars and three trailers the average speed will be 13 miles an hour, measured on the tangents of the Garfield Park line, including stops of 15 seconds each at stations approximately 2,000 feet apart. The present plans contemplate the eventual adoption of six car trains made up of one motor car, equipped with four G. E. 2,000 motors, and five trailers. The average speed of these trains, on some tangents, will be 15 miles an hour, including stops.

The four-track structure has necessitated rather an elaborate system of switches. The interlocking switches are similar to those employed on American steam railways, but have the added complication of the third contact rail, which in some places has to be shifted along with the switches.

There are, of course, numerous details in the construction and equipment of this line which it is impossible to note in this article, but from the principal features

that we have put forward, it is evident that our American friends have brought a great undertaking to a successful issue.

THE CENTRAL STATION AT NANCY.

We had occasion, a short time ago (writes M. Laffargue in *L'Industrie Electrique*) to visit and examine in detail the central station at Nancy. This station was fitted up by the firm of Fabius Henrion under good conditions; its working is conducted on an economical system, which we think it will be interesting to describe in detail.

Description of the Station.—The station comprises a boiler room, an engine room, and various offices and warehouses. The fig. gives a general view of the machinery.

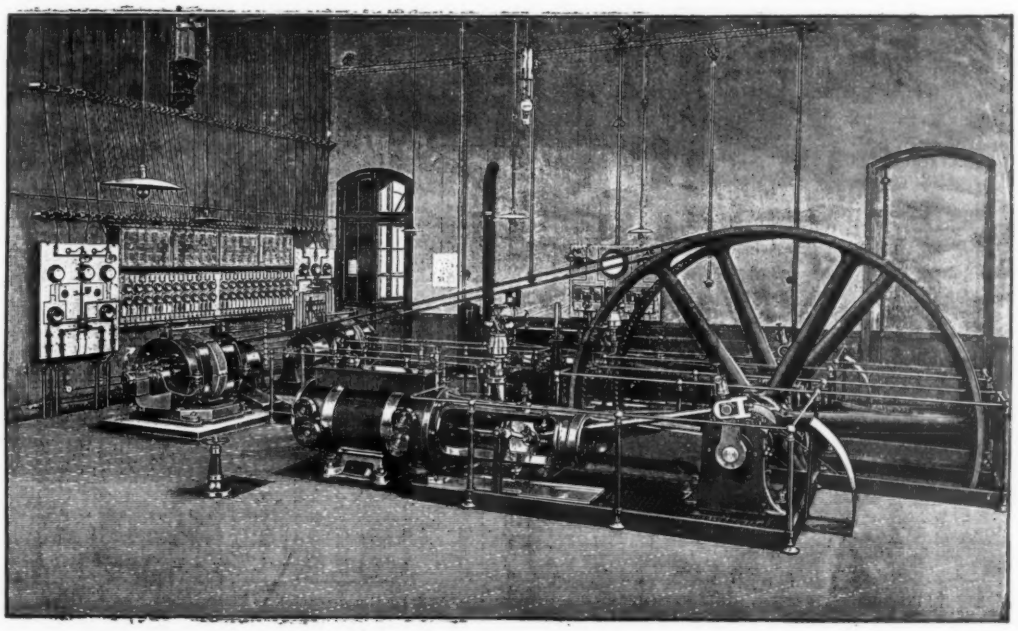
Boilers.—The boiler room contains two semi-tubular steam generators, with a heating surface of 60 square metres, registered at a pressure of 6 kg. per square centimetre, and capable of producing about 750 kg. of steam per hour. The water is conveyed from the Moselle, and is supplied by means of an injector, or, if the injector should be stopped, by feed pumps. A special automatic sluice lessens the draught when the stoker opens the door to make up the fire. The chimney, which is altogether 30 metres high, is placed in the courtyard at a distance of 40 metres. The water obtained from the purifiers and by condensation is sent back to the boilers.

Steam Engines.—The engine room at present contains only two Corliss condensing steam engines, placed at the left; the space on the right is reserved for two other engines. The steam engines have a normal power of 50 H.P., their angular speed is 78 revolutions per minute without load, and 75 when fully loaded. By varying the admission, the power can be brought up to 90 H.P. under good mechanical conditions, but with a greater consumption of steam. The two axles are in continuation of one another, and a special coupling switch enables the two engines to be coupled for working. Under these conditions, if an accident happens to one steam engine or to any dynamo, the remaining engine can drive one of the dynamos, or both at once. Underground rooms have been arranged for the inspection of the engines.

Each steam engine drives, by a belt, an over compounded Henrion dynamo, giving 110 volts and 400 ampères, or 115 volts and 350 ampères, or 40 kilowatts at a speed of 500 revolutions per minute. These dynamos have the advantage of keeping the difference of potential constant, notwithstanding the sudden variations of load.

On leaving the dynamos the current is sent into a special distribution board mounted on marble. This board contains two voltmeters, two ampèremeters, and also a megohmmeter for measuring directly the insulation resistance of the canalisation by a single reading.

Next to this board we find a second one with which are connected the various lighting circuits. The Pilsen arc lamps used for lighting the railway station are 100 in number, and of various intensities (4, 8 and 12 ampères); there are also about 300 incandescence lamps for lighting the offices. The cables consist entirely of insulated wires supported on porcelain insulators. Each circuit of two arc lamps is connected with this board, and is provided with circuit breakers, a rapid interrupter and an ampèremeter enabling the rate of working and the regulation of the lamps to be followed at each moment, thus serving both as an indicator and a measuring instrument. This installation has necessitated a somewhat considerable expenditure at the outset; but it ensures perfect safety and good working to an important and extensive railway station. We may add



Nancy Station.

that the lines, the extent of which amounts to 1,100 metres, serve as resistance, partly taking the place of the usual rheostat, at least for the lines of sufficient resistance.

A second table is intended for the manipulation of two batteries of accumulators of a capacity of 300 ampère-hours. These are available in case of accident, and in the daytime, before the engines have started, and during the night after they have stopped. The accumulators, constructed by the firm of Fabius Henrion, are formed of plates with fine grooves separated by grooved supports and glass tubes. Special precautions have been taken for the installation of these accumulators, and to ensure their insulation with regard to the earth. All the contacts and connections are established by autogenous solderings. An automatic switch serves for the charge and discharge; it couples the accumulators automatically on the general circuit of distribution as soon as the difference of potential falls below a certain value. We will also mention the regulating board; it bears a large voltmeter of 50 centimetres diameter, with large divisions, and two automatic rheostats introduced into the shunt circuits of the dynamos. A registering voltmeter enables the continuous working of the station to be followed exactly.

At 4·8 km. from the Nancy station is the sorting station of Jarville, which also has to be supplied with light. In order to feed the lamps at this distance, a continuous cur-

rent transformer has been employed. An electromotor of 88 ampères and 110 volts at a constant speed drives directly a series dynamo, giving 800 volts and 8 ampères. This dynamo feeds 16 arc lamps of 1,000 candles in series. The intensity is kept constant by the disconnecting of the brushes.

Results of Working.—The Nancy central station is distinguished chiefly for its economical system of working. In the evening the station is in charge of one man only, and during the day one man attends to the arc lamps and replaces the carbons. The superintendent lives at the station. Every day the curves of the registering voltmeter, of the manometer registering the pressure of the boilers, the consumption of carbon, oil, water, &c., are carefully noted, and sent to the Henrion works.

We have been able to obtain some results of working for the month of April, 1893; without stating positively the cost of the available electrical energy, they will furnish some interesting facts, especially as the month of April represents pretty fairly the mean between the full winter service and the greatly reduced service of the summer. The total available electrical energy was 11,666 kilowatt-hours during the month, and the consumption of fuel 22,050 kg. The mean consumption of fuel was 1·970 kg. per kilowatt-hour; this consumption remained fairly constant for each day. The consumption of cylinder oil per kilowatt-hour is more variable; the mean consumption is 5 grammes. The oil for transmissions is not consumed very regularly; it will also be understood that the consumption recorded for one day really serves for a longer period. The mean consumption for the month is 1·96 grammes per kilowatt-hour. We must also take into account the oil collected in the basins belonging to the station and then filtered; during some days, from April 15th to 23rd, about 4 grammes of filtered oil were thus consumed per kilowatt-hour. To render these facts more definite, we will add that the fuel in question is coal sent from the North, and delivered for 22 francs per ton; the cylinder oil is of good quality, and costs 110 francs for 100 kilogrammes; the oil for transmissions costs 40 francs for 100 kilogrammes.

We thus find that the expenditure for material is:—

	Centimes per kw. hour.
Coal, 1·97 kg. per kw. hour, at 22 francs per 1,000 kg.	4·3
Oil for cylinders at 5 grammes per kw. hour, at 110 francs per 100 kg....	0·55
Oil for transmissions, 1·96 grammes per kw. hour at 10 francs per 100 kg.	0·08
	4·93

To get the exact cost, we must add the expenditure for salaries, wages, repairs, maintenance, sinking fund, &c. We will remark, however, that the consumption of fuel for the Birmingham Electric Supply Company in England (see *L'Industrie Electrique*, No. 59, p. 254) was 9·24 centimes per kilowatt-hour, or about 2·2 times as much. It is only fair to add, however, that at the Nancy station the service is more definite and regular than at most central stations.

These few facts show that the Nancy central station is established under favourable and carefully studied conditions; the few figures we have quoted, although very incomplete, show that the working is carried out on an extremely economical plan.

ARMATURE CROSS TURNS IN CONTINUOUS CURRENT DYNAMOS, AND THEIR EFFECTS.

By GEORGE ADAMS.

The distribution of magnetic lines in the air gaps of continuous current dynamos is dependent upon the ratio between the exciting power required to drive the lines of force through the air gap; that is to say, between the ampère turns of the field magnet and the exciting power of the armature cross turns.

Sparkless collection is in a great measure dependent upon the proper proportioning of these quantities.

Fig. 1 shows a section of the armature and pole pieces of a two-pole dynamo. The current is supposed to be going down those conductors marked with a cross. The brushes have a lead in the direction of rotation, their position being

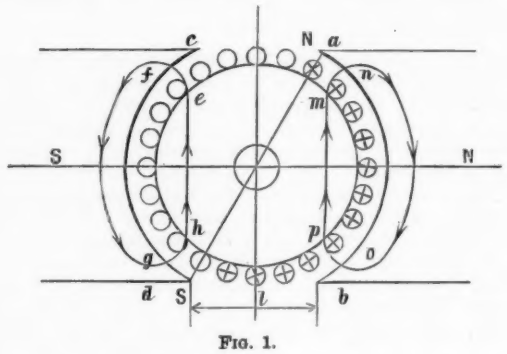


Fig. 1.

usually near to the leading pole tips when the machine is working at full load. In this case the conductors from *a* to *b* and *c* to *d*, namely, those within the influence of the pole pieces, will produce a magnetic field in magnitude proportional to the number of conductors embraced by the pole pieces, the lines of force taking approximately the direction shown by the lines *e*, *f*, *g*, *h*, and *m*, *n*, *o*, *p*. These lines of force will interfere with the lines of force generated by the exciting coils on the field magnets; so that these lines, instead of passing straight through the armature from the N. pole piece to the S. pole piece, are diverted from their course in the manner shown by the thick line, A, B, in fig. 2. The most important point to notice, however, is that the lines of force produced by the cross turns are acting in a directly opposite direction to lines produced by the direct field at *m*, *n*, and *g*, *h*, while at *o*, *p*, and *e*, *f*, the lines produced by the cross turns are acting in the same direction as the lines produced by the direct field. The result of this action is that the lines in the air gap will be crowded up at

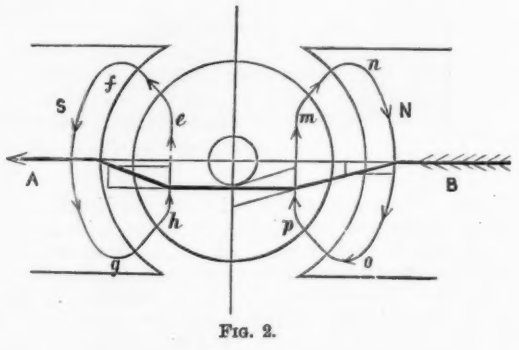


Fig. 2.

the pole tips near *o*, *p*, and *e*, *f*, while at *m*, *n*, and *g*, *h*, there will be comparatively few lines. To deal with the magnitude and direction of the lines of force within the pole pieces and armature quantitatively, would be a somewhat difficult matter, and it is questionable whether any useful practical purpose would be served in doing so.

The iron of the pole pieces and armature offers a path of very small magnetic resistance to the flow of the lines of force, the greatest resistance being in the air gap, and it is in the air gap that the lines produced by the cross turns have greatest effect.

The formula for induction, namely,

$$B = \frac{1{\cdot}257\, c\, \tau}{\frac{l}{\mu}}$$

shows us the relative importance of the iron and air paths.

We may take μ for wrought-iron to be 400, and for air unity.

For iron $$c_i \tau_i = \frac{B_i l_i}{400 \times 1{\cdot}257}.$$

For air $$c_a \tau_a = \frac{B_a l_a}{1{\cdot}257}.$$

If we take the iron path to be 20 times as long as the air path, a usual thing in practice, and $B_a = \frac{B_i}{2}$, we get for iron

$$c_i \tau_i = \frac{B_i \times 20\, l}{400 \times 1{\cdot}257} = \frac{1}{20} \frac{B_i l}{1{\cdot}257},$$

and for air, $$c_a \tau_a = \frac{B_i l}{2 \times 1{\cdot}257}.$$

So that we shall require ten times the ampére turns for the air gap, as compared with the iron path, or

$$c_i \tau_i \times \frac{c_a \tau_a}{10}.$$

Of the cross ampère turns probably nine-tenths will be required to drive the lines through the air gap, and the remaining one-tenth for the iron path. Taking this into consideration with the fact that the lines in the air gap are in such a direction as to have maximum effect in distorting the direct field, we are justified in neglecting the influence of the iron path on the lines of force due to the cross ampère turns, and considering only what takes place in the air gap.

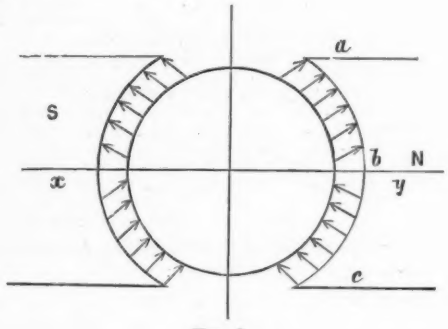


FIG. 3.

The lines of force produced by the armature cross turns will not, however, act along one single line, as shown in fig. 2, but will occupy an appreciable portion of the surface of the pole piece, as shown in fig. 3.

If we consider the effect of the armature cross turns alone, the lines of force produced by the cross turns may be taken as acting in one direction above the axis, x, y, and in the opposite direction below the axis. On the line, x, y, the effect will be zero; in other words many of the lines produced by the cross turns will pass between the turns, as shown in fig. 4.

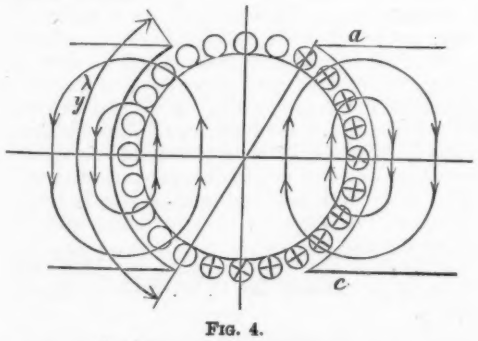


FIG. 4.

Since the current in the conductors within the influence of the pole piece, a, c, is in the same direction in them all, these conductors might be replaced by a shell of copper of a breadth equal to the arc, a, c, and having an area of section equal to that of the conductors; that is to say, so far as the magnetising effect of the current is concerned.

The total current strength in this shell will be $r\, c \frac{\lambda}{\pi d}$ where

r = total external conductors on armature.
c = current in each conductor.
λ = length of polar arc.
d = diameter of armature.

Thus the total current strength is equal to the number of conductors within the influence of one pole piece multiplied by the current in each.

The current per inch, or centimetre of circumference, will be $\frac{r\, c}{\pi d} = \gamma$; that is, supposing the whole of the conductors replaced by a cylindrical copper shell.

(To be continued.)

DANGER IN FLEXIBLE CORD.*

BY C. C. HASKINS.

THE education of the public in matters of hazard from the standpoint of the property owner or the underwriter is by no means an easy task. Mankind is naturally suspicious, and when the attempt is made to instruct, the thought at once comes to the front, "There is something besides sympathy or kindly disinterestedness in all this flow of honeyed words, and I will not heed advice; I will not be compelled if I can help it, and in any event I like to have my own way best."

We are all just now in the transition stage in the use of electricity both as an illuminant and an element of power. The greater proportion of the community knows nothing of its use for either purpose, by experience, and the majority of those who are using it daily know hardly more of its capabilities for good or harm. It seems so easy; everything about it is so simple. All that is to be done is to take a wire and hitch it on here, and hitch on another somewhere else, fasten the two ends to a lamp, turn the key, and lo! you get just as much light as if the work had been done by a high priced man from a first-class electrical firm. The better way, too, as such persons reason, is not to attempt to do this with wire, but to get a flexible cord; "it will give you just as good a light, it can be manipulated so much easier, and it will show much better than an awkward, ill looking black wire."

Now, there are several things about flexible cord that the general public knows nothing of.

Firstly, there are more kinds and qualities of flexible cord —none of them too good—than there are wire manufactories —for each makes several grades—so that when a non-expert, a janitor or a porter, is sent for flexible cord, he thinks he does well when he buys the cheapest, and of course he gets the poorest.

Secondly, a flexible cord is made up of tinsel-like strands of copper, and after a short time the constant handling to which it is subjected is very apt to break these thin strands, with one of two results, if not both. The breaking of one of these will reduce the conductivity of the entire length of cord, and this may result mischievously, for in self-installed applications no care is taken, as a rule, to protect the installation by fuses. Again, the break may permit the broken end to stick through the thin covering of the cord, and thus invite trouble. That point is just so much naked wire on the line, and is abundantly capable of doing mischief under favourable circumstances.

Thirdly, the fact that the two strands of the flexible cord are from the two sides of the dynamo, and if brought together they will make a direct connection from one pole of the dynamo to the other, is either not known, or is ignored by self-created electrical constructors. The only barrier between these two poles, which when brought together are competent for all the mischief which dynamo current is capable of, is the very thin and otherwise miserable insulation which envelops all the cheap varieties of flexible cord.

The season when the electrical fan is to come to the front

* *Western Electrician.*

is upon us. These little one-eighth horse-power motors will soon be heard and seen on every hand. With the heated term some of these come forth from their hibernation, and the electrician who formerly mended washing machines or wringers, peddles some in new places. With 30 feet or more of cheap cord, he shows the uninitiated that a lamp can be removed and an attachment made, and the fan will run, and can be carried all over the room, while consuming only the same amount of current as the lamp for which it is substituted, "because it fits in the same place. See?" The fan motor may or may not absorb more current, may or may not be safe, may or may not eventually create trouble. The wringer electrician doesn't care, and the purchaser doesn't know. The former gets his money cheap, and the latter gets a cheap installation.

A large proportion of the fires from electrical current are due and chargeable to:—First, carelessness on the part of those who, through ignorance, play the *rôle* of experts, and do those things which I have hinted at above; second, wilful transgressions of known electrical laws, such as substituting copper wire for fuse metal where the cut-out strip has melted from any cause; third, overloading circuits which are already as full as is safe. This is often done by exchanging lamps of a lower for a higher candle-power. The general public does not know that an increase of light in a lamp means an increased amount of current consumed; that a wire of a certain capacity is incapable of safely carrying double that amount of current; that when a wire is overloaded the current is partially resolved into heat; that all wires of a given size are not capable of carrying equal amounts of current without heat—iron, for instance, requiring over five times as much cross section as copper. And there are a good many more things about electricity pertaining to safety to person and property that the public has yet to learn.

Anyone can thread a needle and sew on a button, and if a finger gets pricked, no one but the owner of the finger suffers, yet all that doesn't make such an one a tailor. If a tailor undertakes the installation of a motor or an additional lamp, it is not alone his finger that is in danger, for death or a conflagration may result from his ignorance, while he may escape injury.

The use of cord in show windows has proven a very fruitful source of loss to the underwriters, and is not now permitted in any similar locality. Motors in windows, too, have been ruled out in all the larger cities. It is sometimes very difficult to convince a man against his will, but when he is shown by argument and facts that assent is money in his pocket, conviction is comparatively easy and sudden, and there is no argument like that which experience uses. A burned child dreads the fire.

AUSTRALIAN ELECTRICAL NEWS.

[FROM OUR OWN CORRESPONDENT.]

About a year ago I mentioned in a letter that the Hillgrove and Armidale Water Power Company had obtained the right of using the water-power available at the Guyra River Falls, about five miles distant from Hillgrove, and had entered into a contract with the Crompton Electric Supply Company, of Australia, to carry out the necessary electrical work in connection therewith. The work is now completed and in full swing. According to a report by Prof. R. Threlfall, Professor of Physics at the Sydney University, the minimum flow of water is estimated at 564 cubic feet per minute, which, with a fall available of 500 feet, should yield 533 horse-power for conversion at the Pelton wheels. Of this 533 H.P., it is reckoned after deducting various losses that 300 H.P. will be available at Hillgrove. The efficiencies and losses are estimated as follows:—Pelton wheels, 75 per cent. efficiency; dynamos, 94 per cent. efficiency; transmission and leakage, 10 per cent. loss; conversion loss (in motors), 10 per cent.

Five locally made Pelton wheels are used, rope-driving three Crompton continuous-current generators, having each an output of 95 ampères at 1,660 volts, and two Crompton 2,000-volt 25-kilowatt alternators. The continuous current generators are used entirely for motive power, the power being transmitted on the three-wire system, and the alternators for lighting purposes.

Overhead mains are used throughout, the transmission mains being of hard drawn copper, bare, carried on oil insulators, the middle wire of the three-wire system being earthed. 19/13 and 19/16 are used for power wires, and 7/15 for lighting. Owing to the prevalence of lightning, and the rocky character of the country passed through, Crompton lightning arresters are placed at every half mile, the total length of line being about seven miles.

At the Baker's Creek Gold Mine are installed two 50-H.P. motors for driving the stampers, and two 25-H.P. motors for the hauling plant; the Eleanora Mine has for its stampers two 75-H.P. motors and two 25-H.P. motors for hauling purposes; Golden Gate Mine, two 25-H.P. motors driving stampers. With these motors the reversing switch is placed in such a position that a rigid connection can be made between switch and brush rocker, so that throwing the switch over reverses the brushes at the same time.

In the town of Hillgrove four transformers have been installed as feeding points, two of 6,000-watt capacity and one each of 4,500 watts and 3,000 watts, and up to the present about 150 16-candle-power incandescent lamps are connected, with many applications in hand. Some of the underground workings at Baker's Creek are also lit, Callender mains run on insulators being used.

The capital cost was estimated at £15,237 5s., made up as follows:—

Hydraulic plant for 500 H.P., including dam and fluming, Pelton wheels, &c.	£4,000	0	0
300 poles	131	5	0
Copper for mains estimated on 7½ per cent. loss, also insulated wire, &c., for connections and use at Hillgrove	3,130	0	0
Labour of making joints, wiring connecting to motors, &c.	400	0	0
Insulators, 900	83	0	0
Electric machinery, as per estimate	6,241	0	0
Carriage on 36 tons, London to Guyra River	252	0	0
Contingencies	1,000	0	0
	£15,237	5	0

The annual expenses of maintenance are estimated in Prof. Threlfall's report as follows:—

Engineer	£300
Manager	300
Three assistants	375
Contingencies and depreciation	1,200
	£2,175

The revenue is put down at £7,035 per annum from motion and £1,955 from lighting, a total of £8,990 or net revenue of £6,815.

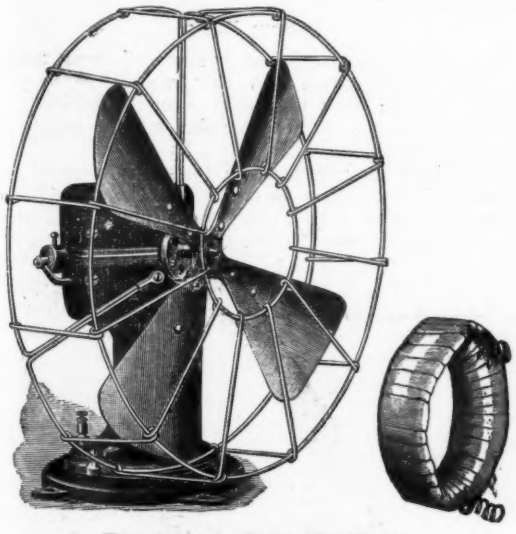
The motor revenue is calculated on a charge of from £30 10s. to £31 per horse-power per annum, 190 horse-power at £30 10s., and 40 H.P. at £31. The lighting revenue is estimated on a charge of 8d. per unit in the town and 7d. per unit at the mines. The average hours of lighting for the town is put down at 5 hours per day, or 109·5 B.T. units per lamp per annum or the very high earning capacity of £3 13s. per 16-C.P. lamp per annum; the mine lighting will, of course, be continuous in most cases and is consequently estimated in some instances on a basis of 24 hours lighting per day; as also is the case with some of the motors, giving naturally a very high load factor for the plant. For instance, the Baker's Creek Mine is stated in the report to have contracted for 90 H.P. continuously for 312 days of 24 hours per annum, in addition to 45 H.P. used occasionally and estimated to be equivalent to 10 H.P. used continuously; the other mines using power on a similar generous scale.

The whole of the electrical work has been carried out under the supervision of Mr. O. W. Brain of the Crompton Company.

THE GLOBE IRONCLAD FAN MOTOR.

Perhaps at no time in the past has the demand for fan motors equalled that which is now compelling manufacturers to operate their factories overtime. Among the fan outfits

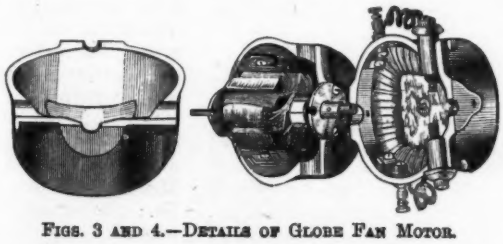
recently brought out is the Globe ironclad motor illustrated in the accompanying engraving, fig. 1, and the details of construction of which are shown in the parts illustrated in figs. 2, 3 and 4.



Figs. 1 and 2.—Globe Fan Motor.

As will be seen, says the *Electrical Engineer*, of New York, the fields are made of two castings or shells, and the field coils, wound separately, are slipped over the pole-piece in each shell section. The armature is built up of the best laminated, imported iron, and a combination winding is used, the effect of which is to increase the efficiency. Carbon brushes are used on all these machines, excepting battery motors, on which a woven wire copper brush is employed. The motor is at once ironclad, dustproof, and free from magnetic leakage.

One of the machines of this type, with a 12-inch six-blade fan, is designed to run on two cells of primary battery for



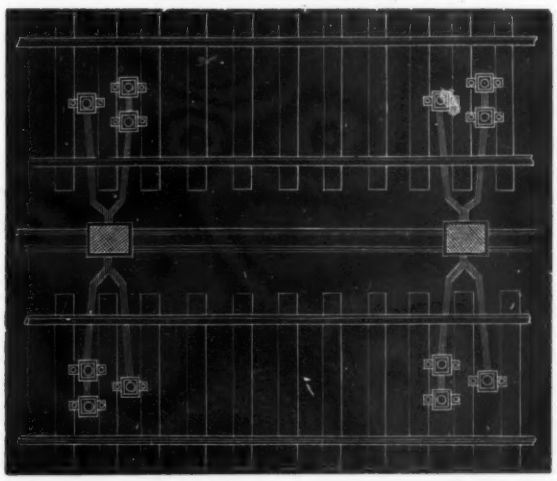
Figs. 3 and 4.—Details of Globe Fan Motor.

20 hours at a cost of 20 cents. These fan outfits are built by Messrs. J. P. Williams & Co., 123, Liberty Street, New York, who also build the same type of machines both as motors and as dynamos in all sizes. As soon as the fan season is closed, the company intend building power motors which will be manufactured up to 50 H.P. The company are at work now on a street car motor, the special features of which will be cheapness, durability, dust and water proof and no external magnetism, therefore avoiding the picking up of nails and other metallic substances in the streets. The patents have all been applied for and some of them allowed.

THE WESTINGHOUSE ELECTRO-MAGNETIC RAILWAY SYSTEM.

The Westinghouse Electric and Manufacturing Company announced recently that it had purchased the stock of the Electro-Magnetic Traction Company, of West Virginia, which controls the Wheless system. This system is now in use on a road in Washington, D.C., and is similar to one patented by Mr. Westinghouse, and with which he has conducted lengthy experiments at Pittsburg. It is stated that the Wheless patents are broader than those of the latter, which led to their purchase. We give below a description of a working model of a car and track now on exhibition at the Westinghouse offices at New York, and which combine the ideas of both Mr. Westinghouse and Mr. Malone Wheless.

The apparatus employed in this system is simple, and the cost of construction, while greater than that of the trolley system, is, according to the *Electrical World*, claimed to be much below that of the ordinary cable conduit. Very little excavation is necessary, and does not involve going deeper than the ties.



The apparatus consists of contact pins located between the rails, and connected, as shown in figure, by wires to switch boxes placed between the tracks, the feeder cables being connected to the latter, and of three sliding contact bars attached to the car trucks.

The contact pins are arranged in groups of three each, and are of cast-iron, 5 inches in diameter, and extend above the pavement $\frac{2}{8}$ths of an inch. They are set in granite or terra-cotta blocks 7 inches square, which, in turn, rest in cast-iron cups having flanges by which they are spiked to the ties.

The group of contact pins are placed about 7 feet apart, and while offering no obstruction to traffic, are sufficiently high to enable the collector bars carried by the car to slide over them, and at the same time entirely clear the pavement. The whole structure is very substantial, and is designed to withstand the heaviest traffic.

Two contact pins of each group are connected by curves to electro-magnetic switch boxes of cast-iron, measuring 12 by 18 by 14 inches, and arranged alongside or between the tracks. These switches are connected to the feeder cable, which is laid in suitable conduits just beneath the pavement, and are provided with electro-magnets having one winding of coarse wire and one of fine wire.

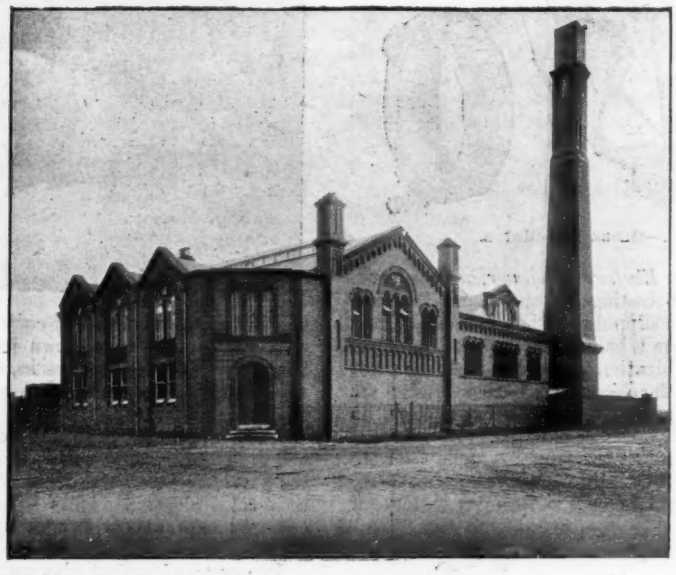
The armature of the magnet is provided with two carbon contacts, each having a contact surface of about 2 by 2 inches, through which connection is made between the feeder wire and one of the contact pins. The magnets and their connections are secured to slate supports, the whole being so constructed that by removing the cover of the box and an inner case, they may be lifted out and examined without the aid of tools, the connections with the supply cable being made and broken automatically. Each car is provided with a three-cell storage battery, and as the car moves along and the collector bars slide over the contact pins, the current from the storage battery passes through the outer contact bar to the corresponding contact pin, and thence through the fine wire winding of the magnet; as the armature is pulled up by the storage battery current, connection is made by the carbon contacts with the feeder cable. The power current passes through the coarse winding of the magnet, holding the armature securely in place, and thence to the motors through the inner contact pin and the corresponding collector bar. From the motors the current passes through the centre bar and third contact pin to the return cable, which is located under the pavement near the feeder cable. So long as the tracks are not occupied by cars, the contact pins are dead, and only become alive while the car is passing over them.

To provide against sparking in the switch boxes, the collector bars are of sufficient length to allow them to slide a distance of 4 feet over the forward set of contacts before leaving the rear set.

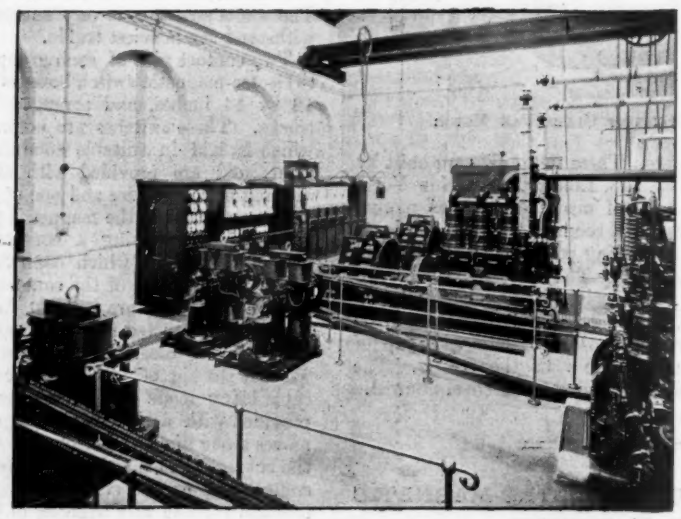
In double track work the switch boxes are located between the tracks, and are provided with two magnets, one for each track. The arrangement of its apparatus in the operation of elevated railways is slightly different from that of surface roads. In place of the contact pins, rails or metal bars, arranged 10 to 20 feet apart, will be employed.

THE LIGHTING OF GREAT YARMOUTH.

The electric lighting question has been periodically discussed by the Great Yarmouth Town Council ever since 1889, when the borough surveyor presented his first report on the subject, and it is largely due to his perseverance and energy that the Corporation, in 1893, called in Mr. W. H. Preece, C.B., F.R.S., to draw up a complete scheme. Tenders were invited on his specification, and the whole contract, with the exception of the buildings, let to Messrs. Crompton and Co., Limited, of London and Chelmsford. The buildings were erected by Mr. J. F. W. Bray, of Yarmouth, to the designs of Mr. J. W. Cockrill, A.R.I.B.A., A.M.I.C.E., borough surveyor. The sub-contractors to Messrs. Crompton & Co. were:—Engines, Willans and Robinson, Limited; condenser, W. H. Allen and Co.; boilers, Babcock & Wilcox, Limited; economiser, Messrs. E. Green & Son, Limited; gas engine, Crossley Bros., Limited; mains, British Insulated Wire Company, Limited.



Exterior View of Yarmouth Station.



Yarmouth Station.—A General View.

Boiler House.

This, at present, contains two water-tube boilers, each capable of evaporating 4,500 lbs. of water per hour, the normal working pressure being 150 lbs. These are provided with a duplicate feed-water ring main and two branches to each boiler. They will shortly be fitted with auxiliary oil-spray injectors, which are intended for use during the few hours of heavy load in the evening, and will also be sufficient to keep the boilers going in case of a coal strike, an emergency which occurs only too often now-a-days.

The economiser is of Green's latest type, and contains 192 pipes. The feed pumps are by the Worthington Company, and the donkey pump by Bailey & Co., Salford.

During the late winter, Yarmouth was three times more or less inundated by the sea, and one function of the donkey pump is to keep the trenches in the boiler house clear of water whenever this occurs.

The boiler house also contains the cooling tanks for the gas engine, the condenser, hot well, and a filter for extracting oily matter from the condensed water, which is then fed into the boilers.

Engine Room.

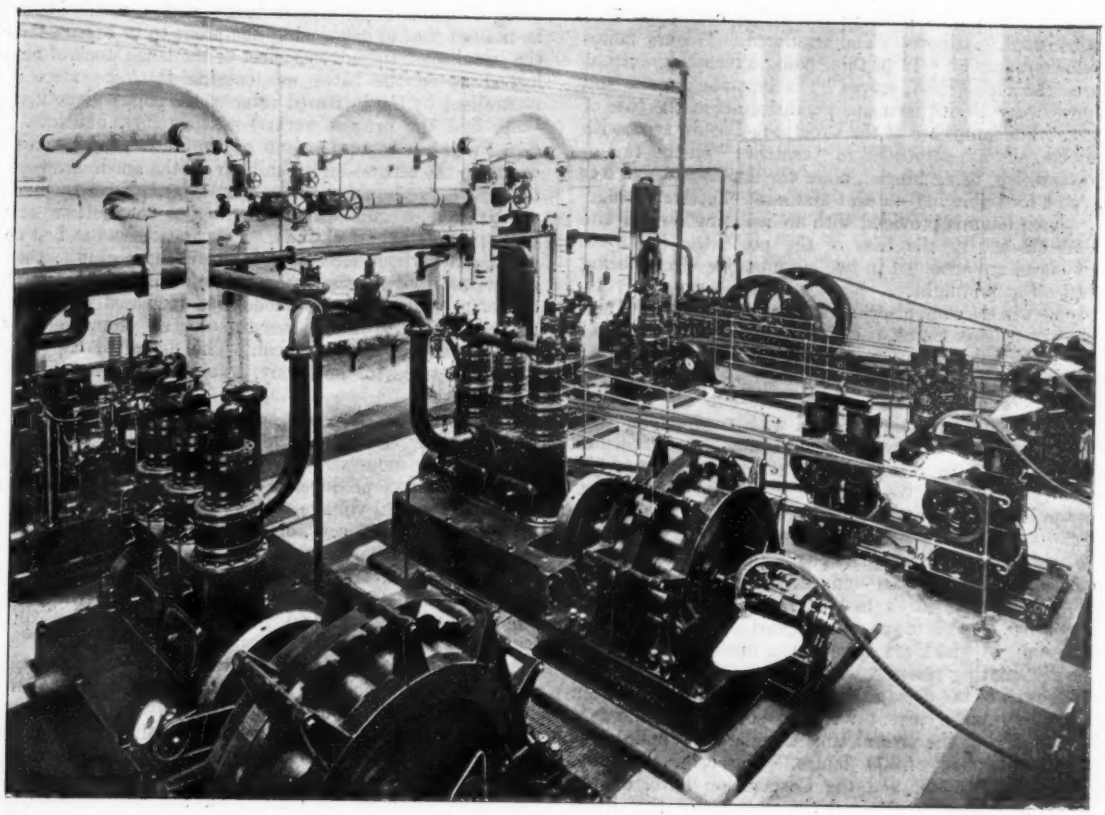
The public lighting plant consists of four 30-light Crompton arc dynamos, each pair rope-driven by a GG Willans engine; they are series wound machines, with Gramme armatures, and no mechanical gear for maintaining a constant current is needed.

The private lighting supply during the hours of small demand is provided for by a 15-kwt. Crompton-Brunton alternator belt-driven by a Crossley gas engine. The steam-driven alternators are 75-kwt. machines of the same make, direct coupled to three-crank Willans engines; two of these are at present installed, and another will be added in the autumn. These alternators are provided with oil pumps for continuous lubrication of the bearings, and the magnets are hinged so that any part of the revolving armature is easily accessible. Each alternator is provided with its own exciter, the exciter armature being mounted on the projecting end of the alternator shaft outside the main bearing.

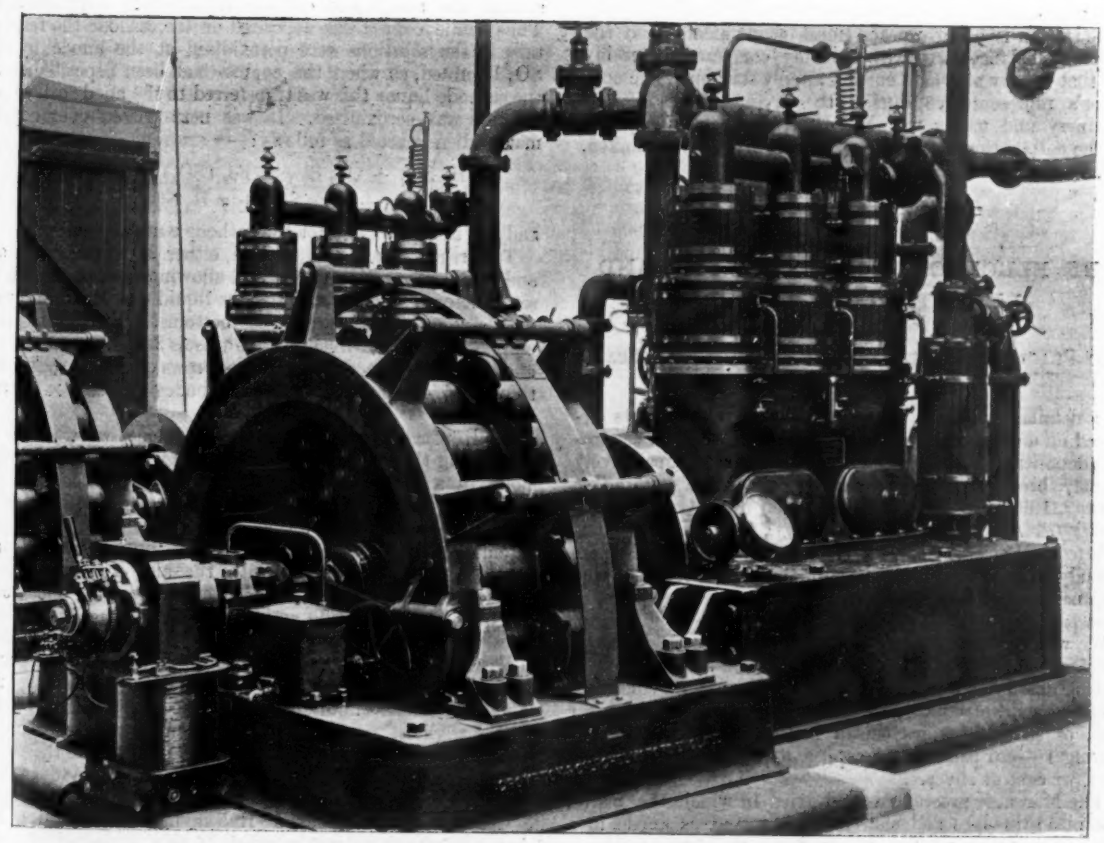
The condensing plant includes a surface condenser, air pump and circulating pump; the pumps are direct driven by a compound engine, and are of the plunger type. Sea water from the harbour is used for cooling purposes. The whole of the steam and exhaust pipes, drains, &c., were erected by Messrs. Crompton and Co.; the former are of wrought-iron, with copper bends. The drains from the main steam-pipe are provided with Royle steam traps, and so arranged, that all the water separated is discharged into the hot well.

The switchboard was designed and erected by the Chelmsford firm, and is chiefly remarkable for the way in which the safety of the attendants has been provided for, it being almost impossible to get a shock from the front of the board. Porcelain is very largely used for both switches and cut-outs, the former being mainly of the four-break plug type. All the instruments, including the electrostatic voltmeters, were made by the same firm.

The board is at present fitted for three dynamos and four feeders, and there are numerous spare panels for extensions. The arc lighting panel accommodates four dynamos and two



General View.



Combined Crompton Alternator and Willans Engine.

circuits, and is so arranged that any dynamo may be instantly switched on to either circuit.

The mains for public lighting are single conductor 7/16 paper insulated, lead-covered and armoured. The arc lamps at present number 63; 11 of these being alternating current lamps on the Fish Wharf, served by a separate circuit, and each provided with its own small transformer at the base of the post. The lamps are of the Crompton-Pochin type, with oval globes, and are suspended in "crutches" on the top of the posts, which, being hinged, allow the lamp to swing clear of the post for trimming—a neat and most effective arrangement. Each lamp is provided with an isolating switch and magnetic cut-out in the base of the post; the 52 direct current lamps are arranged in two circuits, one circuit being switched off at midnight.

Customers in the compulsory area are mostly served by a network of low tension mains, fed by transformer sub-stations; four of these sub-stations were provided in the original contract, and three more have been subsequently constructed by the Corporation; the walls of the last two are made of Cockrill-Doulton glazed tiles, backed with concrete, and the same material has been used in several smaller transformer pits, having been found to make a cheap and thoroughly satisfactory job. The transformers were made by Messrs. Crompton & Co., and are wound for a ratio of 2,000/100 volts, and a periodicity of 83.

The cables for private lighting, both high and low tension, are concentric lead-covered and armoured, of the British Insulated Wire Company's make. Numerous customers in outlying parts of the town are supplied by isolated transformers, some of which are already the nuclei of small low tension distributing systems.

The growth of the demand for private lighting has been exceptionally rapid; current was first supplied on January 12th, 1895, and at the present time there are 93 applications for a total of about 4,800 lamps. The original capital borrowed was £16,500, and the Corporation have, on the advice of Mr. Preece, obtained the consent of the Local Government Board to a further loan of £17,500. This will provide for doubling the size of the present buildings, and plant and mains enough to increase the output of the station about three-fold.

The station is being worked most economically, and the first year's balance-sheet will probably compare favourably with that of any alternate current supply station. The contractor's representative during the laying down of the machinery and mains was Mr. H. H. Reynolds, A.I.E.E., and the corporation electrical engineer is Mr. A. W. Ranken, A.M.I.C.E.

THE ELECTROLYTIC DEPOSITION AND REDUCTION OF COPPER.

Some Practical Experiences on a Commercial Scale.

Two detailed accounts of some practical experiments arranged on a commercial scale in connection with the electrolytic deposition and reduction of copper have comparatively recently been given, the one by E. Jensch (*Chemiker Zeitung*, 1894, p. 1,906) and the other by E. Cohen (*Zeitschrift für Electrotech. u. Elecktrochem.*, 1894, p. 50). It is open to our readers to consult the original papers and there to study what is described; but for the benefit of those who have neither the time nor the opportunity we print a *précis* of these papers.

We will deal with Cohen's paper first. Here is described the process of electrolytic copper deposition as carried on in the Stohlberg Lead Works. The ore to be treated contained 7—8 per cent. of copper, 10 per cent. of lead, and 0·05 per cent. of silver; besides this a matte was produced containing 15—20 per cent. of copper, 5 per cent. of lead, and 0·04 per cent of silver.

The Marchese process was first tried in which the matte, cast into thin slabs and slowly cooled, served as anode in a bath of copper and ferrous sulphate, the ferric sulphate formed being afterwards reduced by causing it to attack fresh regulus. Two Siemens-Halske dynamos of the type C F 17 were used, giving a current of 430 ampères and 35 volts at 700—800 revolutions, the current values per bath being 30 ampères per square metre, and 1 volt. [It is to be noticed that in calculating the profit to be expected from the installation the adverse effect of the large stock of copper locked up in the baths was considered to be more than neutralised by the increased value of the copper deposited.]

At first the process worked satisfactorily, but in a few days the pressure requirements of the bath slowly increased, owing to the separation of sulphur on the anode preventing contact of the liquid with the next layer. Next the honeycombed anodes crumbled and, falling to the bottom of the bath, produced short circuits. Polarisation was at first combated, but without success, by intermittent working; then as it was ascribed to the formation of dioxide of lead, the copper percentage in this anode was increased and that of the lead reduced; but neither this nor an alteration of the iron percentage was effectual. The deposited copper also contained traces of antimony, bismuth, lead, iron, zinc and sulphur.

Leaden anodes were next substituted for the copper matte and the same electrolyte was employed: this lasted longer, owing to the non-extraction of iron from the anodes, but polarisation was produced by the peroxidation of the lead, so that the initial voltage of 1·7 had to be raised to 2·15, whilst only 60 per cent. of the theoretical yield of copper was obtained. To prevent this peroxidation sulphur dioxide from burning sulphur was blown with air into the bath. The resistance was unaffected, but the yield of copper was increased and the metal was of high quality (99 984 per cent. Cu).

One objection to this process was the excessive quantity of sulphuric acid which was formed, which dissolved too large a proportion of the anode and caused crystallisation to take place in the vats. The products of roasting copper sulphide ores were too dilute, but before erecting muffle-furnaces to obtain a more concentrated sulphur-dioxide gas, the Siemens and Halske process was brought out and received a trial.

The installation of this process was entrusted to Dr. Höpfner in 1888. Carbon anodes were used, and the anodes were in separate compartments, with parchment-paper walls, so that the anode and cathode liquids were kept distinct. Thus, while copper was deposited on the cathode the ferrous salts in the solutions were peroxidised at the anode by the SO_4 liberated, so when the copper had been deposited from the cathode liquor this was transferred to the anode cell where the iron was peroxidised. It was next passed over copper matte when it acted as follows:—

$$x\,H_2SO_4 + Cu_2S + 2\,Fe_2(SO_4)_3 = 2\,CuSO_4 + 4\,FeSO_4 + x\,H_2SO_4,$$

and was then available for the cathode compartments.

The regeneration was effected, either by mixing the ore and liquid in rotating vessels and allowing the fine deposit to settle before use, or by running the liquid over the ore in vats with several superposed false bottoms. The baths first employed were lead-lined wooden vessels 2·2 m. × 1 m. × 1 m., and had each 15 anodes consisting of rows of carbon rods 1 cm. thick and 45 cm. long, and 16 cathodes (80 cm. × 80 cm. × 1 mm.).

At Höpfner's recommendation the anodes were joined up by passing the ends to the distance of 3 or 4 cm. through holes in a perforated copper strip, and then coating the projecting ends and the strip with copper electrolytically. The vats were placed terrace-wise, and the cathode liquid circulated from end to end, the anode liquids being transferred through the series with the aid of glass siphons regulated by screw clips. Air was blown into the anode cells to equalise the oxidising action of the current. The siphons were not found to act well, any failure in their part causing an overflow from the anode to the cathode cell. The parchment became swollen and very tender after a few days' use, and the carbons simultaneously became very fragile, so that at the slightest provocation they crumbled and the accumulated fragments at the bottom of the cell broke the parchment membranes. Thus resistance increased, and in nine days the voltage required rose from 0·98 to 1·75.

At this time Siemens & Halske had introduced a new bath (Höpfner's patent) in which 16 cells, separated by parchment paper supported by a wooden frame, contained alternately anodes and cathodes. Side channels permitted com-

munication between like cells, so that the two circulations could be kept up. Air was blown into the anode compartments, and the anodes were carbon rods, as before.

The result of a three-months' trial showed no improvement in working, and when a membrane was broken the whole apparatus had to be taken to pieces in order to replace it, while the rupture of membranes and crumbling of carbons frequently required this to be done. At this stage the Stohlberg Lead Company stopped experimenting in this direction.

We now turn to Jensch's account of the electrolytic reduction of copper by Höpfner's process as carried on at Schwarzenburg from August 1891 to March 1894, and in the Giessen and Weidenau works. It was applied both to rich ore and mattes, and to the cupriferous pyrites from the Sulitjelma mines in northern Norway, in which the copper percentage ranged from 9·5 to 12·25, and that of iron from 34·5 to 32·6.

The ore was very finely crushed, so that 85 per cent. of the sample passed through a No. 220 and 96 per cent. passed through a No. 100 sieve; but some trouble was caused by the blocking of the meshes by the fine powder. The leaching was effected by means of solution of cupric chloride in calcium chloride, which latter (used instead of brine) becomes the solvent of the resulting cuprous chloride, the mixture being placed in revolving wooden drums of 900 to 6,600 litres capacity. The drums caused considerable difficulty by leakage, which began when the temperature of the liquid was raised by the admission of steam to hasten the reaction, and increased with the rise of temperature and the growing percentage of cuprous chloride. Yet for obvious reasons lead and iron vessels could not be used.

With the rich materials available, four extractions sufficed, but with the Sulitjelma ore, although the first extraction removed half of the copper, even 10 or 12 leachings failed to extract the whole of the remainder, partly on account of the large percentage of iron present, and partly owing to the increasing dilution of the liquid. At the temperature of the reaction, magnetic pyrites react with cupric chloride, giving equivalents of ferrous chloride, cuprous chloride, iron bisulphide, and sulphur, while the resulting ferrous chloride reacts with another quantity of cupric chloride to give ferric and cuprous chlorides; and iron pyrites reacts directly with cupric chloride to give ferrous and cuprous chlorides and sulphur. For this reason an excess of cupric chloride must be used in the leaching solution.

The slimes were filter pressed at a temperature of 40°—50° C., in order to avoid the retention of the copper by them. The anodes were of paraffined carbon, the cathodes of thin copper plates. This latter arrangement was adopted because experiments with coppered carbon cathodes had proved unsuccessful. In these experiments the same difficulties with the parchment paper and the short-circuiting caused by detached pieces of copper were encountered as were met with at the Stohlberg works.

It is not the object of this article to discuss their experiences and their teachings, but merely to give the essence of two papers which are chiefly concerned with a bare statement of facts as observed by the persons interested in the practical trials of the processes.

PIPE COVERINGS.

Figures have been presented to the Detroit meeting of the American Society of Mechanical Engineers of some interest as to the efficiency of pipe coverings, the first impression conveyed being the worthlessness of any special claims for largely superior results from the use of any particular material.

The tests were made on a 60 feet length of 8-inch wrought-iron pipe, a length sufficient to remove the test from any charge of insufficiency. The test pipe sloped 1 foot in its length of 60 feet, and tests appear to have been carefully made. The various coverings were put on in the usual manner, and thoroughly dried and warmed before the test was made, and three runs were made with each covering, and the time taken to fill 30 inches of water in the receiver. Thus the goodness of the covering was inversely as the time of the test. A separate test was made with the flanges, the receiver and connections, which were all left bare throughout all the tests, and the condensation due to these parts alone was subtracted from each test result as a correction. The materials tested were magnesia, rock wool, mineral wool, asbestos fire felt, Manville sectional, Manville wool cement, hair felt, Champion mineral wool, Riley cement, and fossil meal.

The 60 feet of bare pipe condensed about 113 lbs. per hour, whereas the various coverings reduced this to from 9 lbs. for hair felt and Manville sectional combined, to nearly 21 lbs. for fire felt, which was the least efficient of the lot, except the Riley cement and fossil meal, which both showed over 37 lbs., and were all through far away behind the rest. These last two only show a saving of 83·66 and 87·20 dollars per year per 100 square feet clothed, on the basis of coal at $2·44, and with 12 per cent. added for cost of firing, and 7 lbs. evaporation. All the others showed from 105 to 119 dollars saved.

The coverings varied considerably in thickness, from ¾ inch for the two worst up to 2·4 inches for the combined hair felt and Manville sectional, but 1¼ to 1½ appeared the average thickness, except for hair felt alone, which was only ·82 inch, and yet gave results among the best.

Speaking generally, the cheaper materials were the more costly to put on as regards labour, but the total cost of hair felt is less than that of any other form of covering.

Practically, if we exclude the two forms which the paper condemns, and which would seem to owe their inefficiency to too great density, there is little to choose between one material and the other. Much must depend on other conditions affecting durability, such as dampness, vibration, exposure to atmospheric influences, and danger of sagging.

Thus mineral wool tends to get to the lower side of the pipe; hair felt is doubtful with high temperatures, and must not be exposed to wet. The tests are strongly emphatic of the need of some form of protection to steam piping, though we know how exceedingly difficult it is to persuade some men to adopt them. The figures given show a saving in one year from four to ten times the cost of the coverings, so that it should pay to cover steam pipes with a covering of the kinds usually employed, if only a life of a year could be secured. With ordinary care and attention, several years of life can usually be secured, and few means to economy pay so well as pipe and cylinder clothing, not simply directly in the prevention of heat transmission, but indirectly in the superior efficiency of steam engines and the avoidance of loss at water drains.

Mineral wool should be well secured to some sort of backing material, and it then becomes a good covering, if kept dry. Above all, while all the good pipe coverings would seem to owe their best qualities to the amount of air they contain imprisoned within their substance, every care must be taken to prevent circulation of such air.

THE THERMO-ELECTRIC PROPERTIES OF PURE METALS.

Those who are interested in thermo-electrics are aware that the state of this branch of our science is by no means satisfactory. Different workers have made divers observations and there exists amongst their results a very pronounced lack of harmony. This is especially the case with the thermo-electric properties of the metals. Hence R. Noll has thought it desirable to redetermine the value of the electromotive force for various combinations, employing the metals in the highest possible condition of purity.

In the first set of experiments the second metal was always mercury, and the temperatures of the junctions were maintained at 100° Centigrade and 0° Centigrade. The method used was that modification of Poggendorff's standard method which is associated with the name of Du Bois Reymond Clark cells of the usual standard pattern were employed as the source of the constant E.M.F.

It appears useful to place on record the results obtained by Noll. These are expressed in microvolts. The + values indicate a current from mercury to metal at the hot junction.

Results.

Metal, &c.	Microvolts.
Bismuth	− 6,705·4
Nickel	− 1,664·2
Cobalt	− 1,522·2
Nickel silver	− 1,085·2
Platinum	+ 4·59
Aluminium	+ 362·4
Magnesium	+ 391·84
Tin	+ 396·03
Lead	+ 402·5
Brass	+ 443·31
Carbon rod	+ 662·88
Silver	+ 710·25
Gold	+ 713·35
Copper	+ 725·58
Zinc	+ 692·71
Cadmium	+ 875·09
Carbon filament	+ 1,452·0
Iron	+ 1,601·4
Piano wire	+ 1,732·3
Antimony	+ 3,379·6

In many cases the effect of small quantities of impurity was strongly marked, not to say great. Hence, some light is thrown upon the discrepancies existing between the observations of previous observers. Thus platinum gave values as high as + 593·88, and copper as low as + 684·29, when these respective metals were not absolutely pure. The state of physical aggregation had also a marked effect in some cases; for instance, silver (710·25; 671·51), zinc (692·71; 735·2), iron, brass, and nickel are examples of this.

The second series of experiments was performed at various temperatures ranging between 0° and 217° Centigrade, a number of observations being made in each case. From the results thus obtained the value for the range 0° − 100° Centigrade were calculated, and good agreement was always observed. In some cases the junctions were formed with mercury and in others with copper. The electromotive force is given according to Gaugain by the equation:—

$$\varepsilon = (t_1 - t_2)\ \{b \pm c\ (t_1 + t_2)\}.$$

The values for b and c are deduced from two experiments and the results calculated by their aid compared with the observations. The agreement is perfectly satisfactory. The value

$$\frac{d\,\varepsilon}{d\,t} = b \pm c\,t$$

is then calculated, and as this can be expressed by

$$b \pm (k_2 - k_1)\,t_1,$$

where k_2 and k_1 are the constants for the different metals at the junction, the numbers are referred to lead for which $k = 0$. The values thus obtained for the thermo-electric power $\frac{d\,\varepsilon}{d\,t}$ are compared with those of previous observers and the differences shown, and such variations as appear are then carefully discussed and explained.

The paper in which this research is described is a long one, and for details our readers must consult the *Annalen der Physik und Chemie*, liii., pp. 874—911.

DOWN DRAUGHT FURNACES.

Down draught furnaces do not appear to have ever been given much attention in this country. Attempts here have been made to underfire coal, and so secure the same conditions that are sought in the down draught furnace, viz., the passage of all green gases through the incandescent fuel in the grate. No under-fired furnace has yet, so far as we know, proved successful.

The down draught furnace, if worked with a good thick fire, would appear to carry within itself the germ of success as a smoke preventer, in that all green gases must become fairly hot in passing down through the fire bed, and therefore burn readily when supplied below the grate with more air. Such furnaces are used to some considerable extent in America, notably in St. Louis, and Mr. W. H. Bryan describes several in a paper read before the Mechanical Engineers' Detroit Meeting. The obvious difficulty is the water grate, especially with bad feed water. A water tube grate can hardly be dispensed with.

In the Hawley grate, circulation is secured by means of a rising pipe carried up to the water surface from the end of each pipe of the grate, thus securing geyser action. Even with a double row of tubes in the grate there is a good deal of unburned fuel drops through, and an ordinary grate is put beneath to catch such fuel, and is, in fact, fed from the grate above by means of the slicer. There are thus two fires, and fresh air is admitted between them. It is found necessary to incline the tubes of the grate some 2½ or 3 inches per foot of length, and as the riser pipes were apt to give trouble, and cause the tubes to become overheated and burn off, it was found better to run all grate tubes into one box and carry up a large riser.

From the paper it would appear that the furnace is really a success as a smoke preventer, but it is not suitable for bad water or poor draughts, especially where there is only a single boiler liable to be stopped by the burning out of a single tube. Glasgow or Manchester public water would admirably suit this boiler, but nothing available about London could safely be used in it, and the down draught furnace can only have a limited field. There are other forms of down draught furnace varying in the arrangement of the grates. One, for example, has a grate of firebrick, but we much question the durability of a dry grate, even of the most refractory brick, and they do appear to rapidly wear out.

Some trials made of a boiler fitted with ordinary and Hawley grates are given, and show an increased evaporation from 6½ to 8½ lbs., from and at, the only change being, besides the grate, an additional 43 feet to the 100 feet chimney, and the almost entire prevention of smoke. The down draught idea is one that attracts, but the subject is full of difficulty, mainly because of the very limited application by reason of the general badness of feed waters. It is of interest rather as showing what may be effected by the system, and what might be equally expected from a reliable system of under-firing. Our contemporary, the *Engineer*, recently made a suggestion of a basket grate for increasing virtual firebox area in locomotives. The basket grate seems to afford one of the more apparently easy means of securing an underfired furnace. All coal would be pushed up from below, and the sides alone of the basket would admit air. Such a furnace would need to be narrow, or the centre would be black. There is a field for invention in a good underfired furnace, but if anyone cares to attempt it, let him be prepared to consider only a very thick fire, without which he will probably fail; and, after all, is there any proved necessity for all these smoke prevention devices, if we will only carry out the same principle, and build a furnace sufficiently surrounded by refractory material to ensure unchecked combustion? In the Hawley furnace, described in the paper before us, the plates above the fire on the water grate cannot receive very much radiant heat from the black fire from which flame all sweeps down through the grate, and after all, the work must be done on the boiler beyond the furnaces. The essence of the down draught furnace is, after all, but perfect combustion freed from the cooling effect of the boiler plates, though the grate itself of water tubes must be a considerable check upon the temperature of the flames from the fire above. Hence we much question if better results are obtained either in evaporation or smokelessness than would be got with a furnace well arched over in brick.

CORRESPONDENCE.

Damage by Lightning.

Permit me to place on record another instance of damage to a house on which a lightning conductor had been erected.

During the thunderstorm which occurred here on May 30th, the residence of Mr. E. B. Mawbey, C.E., borough surveyor, was struck by lightning, eight angle bricks of one chimney being shattered, these being the corner bricks of the 13th to 20th course from the top of the chimney.

The chimney stack struck is slightly lower than, and 17 feet distance from another on which is fixed an elevating rod, with usual finial and 1¼ inch × ⅛th inch copper tape conductor, terminating in a small copper sheet buried under the drive, and within a short distance (probably 2 feet) of the house.

The absolute R *of* this conductor to E is 19·65ω.

No traces of electrical discharge occur at the down spouts at the house corners, but the lead flashing round the chimney at the roof was lifted several inches, and one or two slates displaced.

On examining the interior of the house, I found a ¾-inch iron gas pipe running above the ceiling of the billiard room, with smaller iron pipe branches to right and left along the wall directly under the before-mentioned lead flashing.

The resistance of these pipes to earth, including screwed joints, &c., is only 0·1ω.

It appears to me that a light discharge occurred at the struck chimney, diffused itself over the damp brickwork and lead flashing, and passed quietly to earth *viâ* the iron gas piping. Quantities of soot were displaced in the struck chimney, and one on the opposite side of the house, which was ejected into the drawing and dining rooms; this would doubtlessly be due to discharges of static electricity induced by the initial electrical disturbance.

The thundercloud passed over a number of fine trees in the vicinity of the house prior to its arrival within "striking distance." This again proves the fallacy of the popular idea that trees constitute a reliable means of protection.

J. Lavender.

Leicester.

Municipal Authorities v. Tenderers.

We shall be glad to have your opinion with reference to what seems to us a lack of ordinary courtesy on the part of some local and provincial councils with regard to tenders for electric lighting. We certainly think, when tenders are publicly invited, that, as soon as a decision is arrived at, even if the names of firms competing and the price of the successful tender are not sent to every firm complying with the specification, at least an intimation of the result might be forwarded. We are quite aware that a certain amount of trouble and expense must necessarily be incurred in tendering for this class of work, but surely it is not too much to ask in return for an intimation of the result.

P. G. H.

[We believe it is a custom with the majority of municipal authorities to send a list, such as our correspondent mentions, to unsuccessful tenderers. It is, however, merely a matter of courtesy that those who have spent their time preparing estimates should have official notification of the success or otherwise thereof.—Eds. Elec. Rev.]

Table of Electric Street Railways.

I notice the interesting table of electric street railways in Europe in your last issue does not include a line from Stockholm to Djursholm (Sweden). The line, which is six English miles long, is practically finished; but, as I hear from a relative in Djursholm, there is some hitch in the working. The electrical equipment was supplied by Messrs. Mather and Platt.

The table only credits the Brighton line with two motor cars, and makes no allusion to the Kemp Town—Rottingdean line (in construction), a line absolutely unique, inasmuch as its rails are under water!

Much confusion often arises as to what is the distinction between a tramway and a railway. Surely a railway is any line (whether on a street or private track) that has *fixed* stopping places.

W. Perren Maycock, M.I.E.E.

Croydon, *July 6th.*

Okonite.

Having been interested in the various letters from central stations in this country using okonite wire, I have much pleasure in adding my humble quota to the information which has already been published in your valued paper. We have been using these wires on our overhead system for nearly five years, and have had no trouble whatever with them of any kind, and think they are admirably adapted for high tension current such as we use here. We have also on private property about half-a-mile running through a very thickly wooded park, where in some places the wires are suspended from the trees, and in wet and rough weather have often small branches fallen across them, but during the four years they have been erected, we have not had a single breakdown on them.

Arthur Blake,
Engineer-in-charge, The Fareham Electric Light Company, Limited.

July 8th, 1895.

[This correspondence must now cease. The articles which gave rise to it were directed not so much against the material as against the methods of testing.—Eds. Elec. Rev.]

Electric Railway Signalling.

In your "Notes," in your issue of June 28th, you announce the invention of an automatic railway electric alarm for level crossings.

I shall be glad if you will notify that an electric arrangement—which does exactly the same thing—has been successfully working at several points on this railway for the last six years.

John Neale,
Superintendent and Engineer, North Staffordshire Railway.

Stoke-on-Trent, *June 28th*, 1895.

LEGAL.

Edison-Swan Company *v.* Williamson.

This action, which is to restrain an alleged breach of a license, was again mentioned on Thursday last week before Mr. Justice Stirling. Counsel for the plaintiff company said that the defendant had given an undertaking in terms of the notice of motion, and the action would be set down at once for trial. The motion for interim injunction would stand over on these terms until the trial of the action. Counsel for the defendants said that the undertaking was given without prejudice because his clients contested the plaintiff's case altogether. It was, however, a case in which there must be cross-examination, and that would be best taken at the trial. His Lordship directed the motion to stand over on these terms.

Edgeley *v.* The Metropolitan Electric Supply Company.

On Thursday last week, before Mr. Justice Stirling in the Chancery Division of the High Courts, Mr. Warrington, Q.C., again mentioned the case of Edgeley *v.* The Metropolitan Electric Supply Company, Limited, in which the plaintiff sought an injunction to restrain the defendants from erecting a wall so as to interfere with his ancient lights. Counsel stated that the parties had now come to terms upon which he would ask the Court to stay proceedings in the action. An order was made accordingly.

BUSINESS NOTICES, &c.

Agency.—Mr. G. Straus has been appointed sole agent for the United Kingdom and the Colonies, by Messrs. Schiff, Jordan and Co., of Vienna.

Auction Sale.—On Tuesday next, 16th inst., Messrs. Wheatley Kirk, Price & Goulty will sell by auction at the steam saw mills and joinery works, Morland Road, Croydon, the buildings, engines, boilers, and plant, &c., by order of the mortgagees in *re* J. W. Hobbs & Co., Limited (in liquidation).

Bankruptcy Proceedings.—A general meeting of the creditors in the failure of Mr. J. T. Todman was held last Friday at the London Bankruptcy Court. The chairman stated that the business was to consider an offer put forward by the debtor providing for a composition of 7s. 6d. in the £, by instalments extending over nine months. Upon a vote being taken, the chairman declared the

debtor's offer had not been accepted by the statutory majority, and the estate would consequently remain in his hands to be administered in due course.

At the Newcastle Bankruptcy Court on 2nd inst., David Lamont, electrical instrument dealer, late of 44A, Blackett Street, Newcastle, was examined. He said he had been in the business since June, 1878. Previous to that he was a millwright and mechanic, then he was an agent for sewing machines, afterwards an evangelist for the Free Church of Scotland, and then he entered into the agency for magnetic belts. He found himself insolvent five or six years ago, but he was not pressed, and he had not contracted much debt since then. When he found himself in that position he went on, because he expected he would be able to pull round. The examination was adjourned for a week.

Catalogues.—"Rope-Driving" is the title of a pamphlet which has been written and published by Mr. Thomas Hart, of Blackburn. Mr. Hart discusses, firstly, the advantages possessed by rope-driving, as compared with belt driving or wheel gearing, and considers the rope-driving system as the cheaper, more reliable, and more effective means of transmitting power. The writer also draws attention to some of the points essential to successful rope-driving, devoting several pages to this very important part of the subject, and concludes with a few details of the principal features of the Lambeth rope. The pamphlet is well illustrated.

Change of Address.—The Nalder and Harrison Construction Syndicate have removed their offices and works from 47, Victoria Street, S.W., to Trafalgar Works, Bow Common Lane, E.

Electrically Propelled Pleasure Boats.—In reference to the letter in our "Correspondence" columns last week, Messrs. New & Mayne write us as follows: "We have a new apparatus which would, we think, suit 'Electric Launch' very well. It is a specially designed rudder motor (weight, 50 lbs.), which is fixed on just as any ordinary rudder, and the steering lines bring the current to the rudder from 12 secondary cells, which are made up in two suitable boxes 18 inches × 10 inches × 10 inches (weight, about 200 lbs.). A switch enables the boat to go either direction, any speed up to six miles an hour. The complete apparatus weighs about 250 lbs., and can be fixed in a few minutes. We have six of these rudders working at Henley Regatta this week, and shall be pleased to make appointments anywhere on the Thames to see them."

Good Dividend.—We hear that Messrs. Schuckert and Co., of Nuremburg, are declaring a dividend of 10 per cent. for the last financial year, as compared with 9 per cent. in 1893-4.

New Blotting Paper.—From Messrs. Robert Craig and Sons, of Caldercruix paper mills, we have received specimens of their "Spongia" blotting paper, which compared with many blottings made under other processes, possesses superior powers of absorption, and lasts longer.

Price Lists.—From the Unbreakable Pulley and Mill Gearing Company, Limited, we have received a copy of their new price list of "Unbreakable" pulleys, adjustable and swivel bearings, bright steel shafting, and other articles for the economical transmission of power.

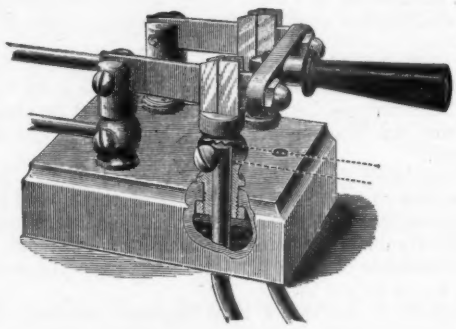
Sell's Directory of Telegraphic Addresses.—Mr. Sell has sent to us a copy of the June supplement of his "Registered Telegraphic Addresses," which supplements and corrects the information supplied to his subscribers up to, and including, May 31st for London, and May 9th for the provinces. By permission of the Postmaster-General, the compiler is now able to state the trade or profession of firms in the alphabetical lists, and will be pleased to add this information in the next edition without charge, if firms will kindly inform him what their business is.

The Action against Sir Augustus Harris.—In the Westminster County Court on 8th inst., the case of Humphreys *v.* Harris came before Judge Lumley Smith, Q.C., and was an action tried before his Honour and a jury the previous Monday, and was referred to in our last issue. It will be remembered that the Judge gave the jury several questions to answer, and after an hour's consideration, they found for the plaintiff for £25 but, owing to the nature of the answers to the questions, his Honour reserved his judgment till 8th inst. Mr. Scott then applied on behalf of the defendant for the verdict to be set aside and a new trial given. Mr. Lambert, counsel for the plaintiff, asked for judgment for the amount given by the jury. He submitted it was a proper verdict. His honour said the plaintiff was entitled to his verdict. He had some hesitation about it, but at the same time did not think he ought to set aside the verdict of the jury. Judgment was therefore entered for the plaintiff for £25 and costs.

The Lagrange-Hoho Process.—We are informed that a company is in course of formation to acquire and exploit the Lagrange-Hoho process for the electric treatment of metals, in Switzerland. A practical demonstration of the process has lately been given at the Central Electric Lighting Station at Fribourg.

The St. Martin's Electrical Manufacturing Company, Limited.—We are asked to state that pending an amalgamation of its business, the company has temporarily removed the office to the works address, 44, Blythe Road, West Kensington, W.

Jack-Knife Switch.—We take the following details of a neat and practical jack-knife switch, with a carrying capacity from 15 to 25 ampères, supplied by the Electric Engineering and Supply Company, of Syracuse, N.Y., from the *Western Electrician*:—The switch, which is shown in the illustration, is mounted on a porcelain base, fitted with combination terminals which will admit of both a top and a rear connection, the wires being held in either case by the same screw. It is small and compact, being only 2½ inches long by 1⅞ inches wide, and is 1¾ inches high, base included. This little switch has become a great favourite in the construction of panel



board work, and has supplanted many snap switches. The company also furnishes switches of this style without the porcelain base, so that they can be mounted directly upon the slate.

ELECTRIC LIGHTING NOTES.

Ashford.—The District Council has appointed a committee to consider the question of gas *v.* electricity for lighting the town, and has decided to oppose the application of the Guildford Electric Supply Company for a provisional order.

Birkenhead.—The Council recently accepted the tender of Messrs. Holme & Green, of Liverpool, for the erection of a central station for £4,440. The firm afterwards discovered that one of their sub-contractors had made an error of £378 in their contract. The Finance Committee recommended the alteration of the sum to £4,818 accordingly, but this recommendation has been referred back by the Council.

Brighton.—A local newspaper says that the electric light that was promised for the Marine Parade, and various leading thoroughfares in Brighton, seems likely to be for some little time to come a thing of the future. The Corporation, it appears, is not yet prepared to start the light, and, in consequence, is to hold over the notice to discontinue the lighting of those thoroughfares by gas until September 30th.

Bristol.—We understand that the Electric Light Committee are making every arrangement for the extension of the installation in the autumn. The new cables are being made, and are expected to be delivered by the end of the present month, and the extensions to parts of Clifton and Bedminster, Broadmead and Stoke's Croft will then be actively commenced. It is intended to have these new sections ready for the use of the light by September 1st.

Cape Town.—Mr. J. Woodhead, who has been Mayor of Cape Town on three occasions, and is at present paying a visit to this country, has been interviewed by a representative of the *British and South African Export Gazette*. Mr. Woodhead, in reference to electric lighting matters, remarked that the Graaf electric lighting works, which had just been opened when he left South Africa, already seemed, as a municipal undertaking, to have reached a successful issue. The current is supplied by a plant of turbines and steam engines, both being in duplicate. Water for the turbines is supplied from the top of Table Mountain, through the Woodhead tunnel. After being used by the turbines, it is passed into the reservoir for drinking purposes. Owing to the absence of rain, for some time past the dynamos were worked at the start by steam power, but in the future, with the new water supply available, they will always be able to produce the electricity with the turbines. It is hoped that the light will be cheaper than gas. It has been resolved to charge 1s. 2d. per Board of Trade unit, but the electrical engineer feels certain that it can be supplied for 8d. "We want to be sure of our capacity to produce the current at the latter rate before we make a reduction. There have been many applications for the use of the current for lighting purposes, but of course, development in that direction will be held back until the public lighting is thoroughly in order."

We understand that 50 additional arc lamps are to be put up in the Cape Town thoroughfares.

Compton Gifford.—A Plymouth paper says that the County of London and Brush Provincial Electric Lighting Company intend applying for a provisional order for electric lighting. The District Council has referred the matter to a committee.

Cork.—Three companies having given notice of their intention to apply for a provisional order for electric lighting within the city, the Corporation has appointed a Committee to consider the matter.

Dover.—In the course of a discussion the other day regarding the electric lighting of the Connaught Hall, Alderman Peake said that, according to last year's average, the use of the electric light in the Town Hall would cost £112 10s. more than gas.

Dundee.—A statement was submitted to the Gas Committee last week with regard to the gas and electricity rentals during May and June. The gas rental was £5,009 16s. 9d., and the electricity rental £164 1s. 5d., being a decrease of gas compared with the corresponding months last year of £394 13s. 4d., and of electricity of £13 7s. 2d.

East Grinstead.—The electric lighting question is very prominent here just now. Householders are being canvassed as to their feeling in the matter, and it is proposed to form a company. We learn from a local source that the consulting engineers to the undertaking are Messrs. Owen, Lucas & Pyke, of Victoria Street, S.W.

Eastbourne.—The Eastbourne Electric Light Company has reduced its price per unit from 9d. to 8d. for current supplied to the Town Hall and bandstand.

Edinburgh.—At a meeting of the Electric Light Sub-Committee, it was decided to recommend the Council to increase the salary of the resident engineer (Mr. Monkhouse) by £100, making £400 per annum.

The Treasurer's Committee of the Council has decided to recommend that the electric light be introduced into the Waverley Market, at a probable cost for the installation of £650, and that a system of ventilation be carried out by rotary fans, propelled by the electric current, at a probable cost of £500.

Great Crosby.—At the last District Council meeting two companies gave notice of their intention to apply during the next Parliamentary session for provisional orders for electric lighting within the Council's area.

Hampstead.—The Vestry has decided that an electric lighting main for supply to consumers be laid down from the West End Lane extension along Inglewood Road to the corner of Holmdale Road, at an estimated cost of £86; that three smaller high pressure feeders be substituted for the one large feeder ordered for the High Road, Kilburn, extension, at an additional cost of £271; that two smaller high pressure feeders be substituted for the one large feeder ordered for the West End Lane extension, at an additional cost of £76; and that the necessary alterations be made in the panels of the switchboard at the central station, at an estimated cost of £15.

Ilfracombe.—An electric light company intend applying for a provisional order for lighting the town. The District Council are to consider the matter at a special meeting.

London.—The Commissioners of Sewers have decided, upon the recommendation of the Streets Committee, that the three sums of £1,000 each, deposited as security for the due fulfilment of the contracts entered into for lighting the City by electricity, be refunded to the City of London Electric Lighting Company, together with the interest that had accrued thereupon, the conditions of the contract, so far as the company was concerned, having been complied with.

Collins's Music Hall is to be lighted by electricity, and an installation is now being put in.

London County Council and Electric Lighting.—At this week's County Council meeting it was agreed that, subject to an estimate being submitted by the Finance Committee, as required by the statute, the Highways Committee be authorised to take all the necessary measures for establishing, at a cost not exceeding £16,590, electric lighting for the Victoria Embankment, and the Waterloo and Westminster bridges (but exclusive of the Embankment Gardens) authorised by the Council's (General Powers) Act, 1893; and that for this purpose the committee be authorised to obtain tenders and to enter into contracts on behalf of the Council.

Monifieth.—At a meeting of ratepayers, held on 4th inst., to discuss the lighting question, the Convener of the Lighting Committee (Mr. R. S. Barrie) said that the erection of a local gasworks, suitable for Monifieth, would cost about £2,500. Referring to electric lighting, Mr. Barrie said that if a central station were erected at Milton, and advantage were taken of the Dighty water for the motive power, this could be done for about £5,000. The question was deferred for nine months.

Newport.—A Local Government Board inquiry was held on 4th inst. into the application of the Town Council for power to borrow £9,725, the wiring and fitting of the Town Hall for electric lighting being one of the items.

Provincial Electric Lighting Bills.—Mr. Mellor (Chairman of Ways and Means) in the House of Commons had before him last Friday a Bill to confirm a provisional order made by the Board of Trade under the Electric Lighting Acts, 1882 and 1888. The order in question is to enable the Liverpool Electric Supply Company, Limited, to supply electricity in respect of a part of the city of Liverpool. The Bill has already passed through the House of Lords, and after hearing the necessary formal proofs, Mr. Mellor ordered it to be reported for third reading in the Commons.

Another order, giving similar powers to the Corporation of Bootle, was advanced to a similar stage.

A third order, granting powers to the British Insulated Wire Company, Limited, to supply electricity to the urban district of Prescot, was similarly advanced.

Sale.—The Bowdon Electric Lighting Company want to apply for a provisional order for electric lighting the district. The Council are to consider the matter at a special meeting. Several members have expressed themselves in favour of the Sale Council keeping the powers in its own hands.

Scarborough.—A committee having considered a tender received from the Scarborough Electric Supply Company, Limited, for the lighting of certain streets in the borough at a cost of £915 odd, and compared it with that of the gas company, which comes to £349 odd, have resolved that electric lighting cannot be entertained at present. The gas company are to light all the lamps in the borough at 2s. 3d. per 1,000.

Shoreditch.—The Board of Guardians recently received a letter from the Vestry, asking whether they would be likely to require a supply of electricity for their establishment. The Vestry has replied that if the Board instituted electric light, they would prefer to have it under their own control, and, therefore, would not require to be supplied by the Vestry.

Southport.—The Local Government Board has sanctioned an additional loan of £14,428 for electric lighting, but has struck off over £1,000 for a defective chimney, the cost of an electrical display, and cost of provisional order.

Stretford.—The Manchester Suburban Electric Supply Company intends applying for a provisional order for lighting the district electrically. The Highways Committee of the Council are to consider the matter.

Train Lighting.—According to a contemporary, orders have been placed by the Natal Government Railways for fitting up a dozen railway carriages with electric lighting batteries, fittings and lamps.

Wells.—At the Town Council's last meeting, a letter was read from Messrs. Davies & Roach, regretting they were unable to return the electric lighting contract signed by Mr. Dixon Browne, and suggesting the appointment of another electrician. The Council is to consider the matter.

Weybridge.—The District Council discussed, the other day, a recommendation of a Committee that the present contract for the public lighting be allowed to run out. According to the *Surrey Advertiser*, the Committee further suggested "that the Clerk write to the Weybridge Electric Lighting Company, stating the Council would not require them to submit a contract for lighting. Mr. Bilney moved that no definite steps should be taken by the Council as to the future lighting of the village until a public meeting of ratepayers shall have been held. Dr. Powell seconded. Mr. Bilney thought the Council should have expert opinion on the matter. Mr. Chalmers moved, as an amendment, that if the Highway Committee, after consideration, thought it desirable, a public meeting should be called to consider the future lighting of Weybridge. Mr. Rowland seconded, and the amendment, on being put, was carried. It was also resolved to appoint a small committee, and to employ an engineer."

Wimbledon.—Before further considering Mr. Preece's report on the subject of electric lighting, residents are to be circularised as to what support they would be likely to give in the event of an installation being carried out.

Wolverhampton.—The Lighting Committee of the Corporation have adopted a recommendation to extend the electric lighting system to other parts of the borough, at a cost of about £5,000. This includes further plant, to be supplied by Messrs. Thomas Parker, Limited, for £2,230, another engine for £845, and mains to cost £536.

Worcester.—At the last City Council meeting it was stated that the engineer, Mr. Murray, had reported that from January 1st last to June 17th, the quantity of coal delivered at the generating station was 383 tons 9 cwts. 1 quarter, of which the Brush Company had used for testing purposes 65 tons 1 cwt. 2 quarters, leaving a total consumption for steaming, &c., of 318 tons 7 cwts. 3 quarters, and that during the same period the use of water-power and steam-power had been as follows:—

	Days.	Per cent.
Water power only	101 ...	60·85
Water and steam-power ...	52 ...	31·32
Steam-power only	13 ...	7·83
	166	100

Mr. Murray explained that the use of steam had been somewhat increased, owing to the damage to one of the turbines; and that, until the month of June, steam was used through want of head owing to floods, and during June through lack of water in the river.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Douglas and Laxey Electric Tramways.—The arbitration case to which we referred last week has been settled, an amicable arrangement having been come to between the parties. The terms agreed to were that the electric tramway company should pay Mr. Hall £250 for the land, and all costs.

Electricity on the U.S. Elevated Roads. — Quite a flurry was created the other week, says the *Electrical World*, by a positive announcement in the daily papers that the management of the Manhattan Elevated Railway system had entered into a contract with the Westinghouse Company for the equipment of its lines with electric power—the contract calling for an expenditure of $8,000,000. The following day as positive a contradiction of the report was published on the part of the Manhattan Company, but with the admission that while it had not yet been definitely decided to abandon steam power, that matter was being seriously considered, and that an examination is now under way with a view to finally determining the question. It was also denied that any preliminary arrangement had been entered into with the Westinghouse Company, or that the rivals of that company would be discriminated against in the purchase of a prospective equipment. While the adoption of electricity is thus not yet absolutely determined upon, it seems very probable that the time is near at hand for that consummation.

South African Mines.—It is stated that more powerful dynamos have been ordered from Messrs. Easton, Anderson & Goolden, Limited, for the work of driving the 10-stamp battery of the United Ivy Company, De Kaap. At present it is working with a drop of 6 inches instead of 8 inches.

Tramcar Accident in America.—On 8th inst. an electric tramcar left the track at East Liverpool, Ohio, and fell over the embankment. One passenger was killed and 18 seriously injured.

TELEGRAPH AND TELEPHONE NOTES.

Submarine Cables.—Writing to the *Society of Arts Journal*, Mr. John P. Hooper (of Hooper's Telegraph and India-rubber Works, Limited) says:—"Under the heading of 'General Notes' in your journal of June 28th, mention is made of a total length of all the cables laid up to the present time as being about 157,713 nautical miles, of which length 1,900 is stated to be insulated with India-rubber. This figure is not quite in accordance with facts, as to name only two companies who make use of India-rubber (Hooper's) core. The Great Northern Telegraph Company of Copenhagen, and the Cuba Submarine Telegraph Company have at work at the present time about 4,000 miles of Hooper's India-rubber cable cores. Altogether about 9,000 miles of submarine cable have been laid containing Hooper's India-rubber core, the list commencing with the cable laid in 1867 between Ceylon and India. It may also be of interest to know that Hooper's India-rubber cable core, supplied in 1868 and later, is being re-sheathed for further use."

New Telegraph Lines in Argentina.—The *Financial News* Argentine correspondent says that Messrs. Mitano & Grether have solicited from the National Government the concession for 10 years of a telegraph line commencing at Port Rawson (Chuput) to Buen Suceso Bay, fronting Staten Island.

The Postmaster-General has asked the Minister of the Interior permission to open to public service the new telegraph offices at Lajan (San Luis) and Villa Aberastain (San Juan).

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—July 24th. The Electric Committee invite tenders for the construction of street culverts, supply of C.I. pipes and frames, insulators, insulated cable, copper strip, &c. Particulars from the engineer at the Central Station, Chapel Lane.

Belgium.—The Belgian State Railway Authorities in Brussels are at present inviting tenders for the supply and erection of plant for the electric lighting of the railway station, the locomotive shed, and the carriage and waggon shops at Schaerbeek-Nord. The contract does not include the supply of the necessary engines, boilers and shafting, but comprises the dynamos, switchboards, conductors, masts, lamps, &c. Tenders are to be directed to the Chemins de Fer d 'Etat Belge à La Bourse, Brussels.

Blackburn.—July 13th. Tenders for wiring the Town Hall must be in to-morrow.

Brighton.—July 15th. Tenders are invited by the Corporation for piping, storage tanks, filters, feed pumps, economisers, &c., for the electricity works.

Brighton.—July 15th. Tenders are invited by the Corporation for condensers, air pumps, piping, &c., for the electricity station.

Bristol.—The Committee of Visitors of the Bristol Lunatic Asylum, Fishponds, are inviting tenders for supplying and fixing the necessary wires, lamps, &c., for lighting the building by electricity.

Datchet (Berks.).—July 20th. Tenders are wanted for lighting the village of Datchet, for the Barker's Bridge House Trust, during October to March, with oil, gas, or electricity. The present number of lamps is 33. Further particulars to be obtained from the Trustees of Barker's Bridge House Trust, care of Mr. H. L. Prior, The Priory, Datchet.

France.—August 11th. The Municipal Authorities of Ille-sur-Tet (Pyrénees Orientales) are inviting tenders for the concession for the electric lighting of the town. Tenders should be directed to the Mairie d'Ille-sur-Tet (Pyrénees Orientales), France.

Hapton.—July 15th. The Parish Council is inviting tenders for the electric lighting of the village of Hapton from September 1st to April 30th, 1896. Number of lights required will be about 50.

Holland.—August 9th.—The Minister of the Waterstaat at the Hague, is inviting tenders for the construction of a new post and telegraph office in Amsterdam. Tenders to above.

London.—July 18th. The Metropolitan Asylums Board invites tenders for the supply and laying of mains, and for the wiring of buildings now in course of erection at the North-Western Fever Hospital, Haverstock Hill.

London.—The London County Council will shortly be advertising for tenders in connection with the proposed electric lighting of the Victoria Embankment and Waterloo and Westminster Bridges. The sum to be spent is about £16,590.

Malta.—August 1st. The Crown Agents for the Colonies and the Receiver-General and Director of Contracts at Valletta, Malta, are inviting tenders for the supply of materials in connection with the installation of the electric light in the civil and war department buildings in Malta. Further details will be found in our advertisement pages.

Rangoon.—November 4th. The Municipal Committee is inviting tenders for electric lighting. Particulars to be obtained from Messrs. Ogilvy, Gillanders & Co., 67, Cornhill, E.C.

Roumania.—Tenders are at present being invited by the chiefs of the Regiment I. "Cetate," in Focsani, Roumania, for the supply of 5,000 metres of telephone cable and 8 sets of station apparatus.

Roumania.—July 29th. The Municipal Authorities of Braila, Roumania, are inviting tenders for the concession for the construction and operation of an electric tramway along the main streets of the town.

Wellington.—July 15th. Tenders are invited for lighting the Wellington (Salop) urban area or lighting district with gas or electricity, for the Urban District Council. Particulars from the surveyor, Mr. G. J. Monson, C.E., 45, Walker Street, Wellington.

NOTES.

Boiler Efficiencies.—Commenting upon the standard code of boiler performance reports adopted by the American Society of Mechanical Engineers, Mr. F. W. Dean thinks there is likely to arise a good deal of misconception, especially in the use of the term combustible as applied to coal. It is wrong to quote the percentage of ash and moisture in a fuel, and call the remainder combustible, for the calorific value of two coals apparently equal may be several per cents. different. For purposes of discussion, he suggests a new code, which embodies 79 different statements to be filled up of the data as to dimensions, pressures, temperatures, fuel, water, and evaporation, and unit rates of combustion, &c. In discussing the paper Mr. Barrus, as might be expected from the inventor of the Barrus calorimeter, objects to fuel being rated from its chemical composition. He would rate it by its actual test in an oxygen calorimeter, and so put the whole duty of boiler testing upon the engineer rather than any of it on the chemist, and we think he is right in this. At the same time we would hesitate, even with the most elaborate rules, to lay much stress upon boiler comparisons, seeing that so very much depends upon the personal element, the skill of the fireman, and various points that cannot be allowed for with the accuracy and certainty that accompany an engine test. As the author states, there are so many silly guarantees given for boiler performance just to secure orders. If purchasers of boilers would refuse to listen to boiler makers and use their own sense, or pay for expert opinion, they could form a judgment on any boiler without any need for guarantees, other than for workmanship.

The Sardinia Street Fire.—The *Finance Chronicle* last week considered that the entire destruction of the dynamo room at the Sardinia Street station of the Metropolitan Electric Supply Company, occurring so soon after the serious fire at Kensington Court, will probably lead to this class of risk being regarded by the fire offices with less favour, and the adequacy of the current rates may be called into question. The loss involved by the fire will probably not fall far short of £20,000. Although it is evident that the fire had an electrical origin, the precise cause is not quite clear. It probably arose through a defect in one of the connections or resistances attached to the portion of the switchboard at which the flames broke out. This switchboard was of immense size, the length being 54 feet and the height 11 feet. It stood about 2 feet away from the wall of the dynamo room, the intervening space being just sufficient to allow workmen to pass behind for the purpose of making or renewing the multitudinous connections. The front of the board was divided into 20 panels, the base of each panel being of enamelled slate framed in polished wood. The fire spread with the utmost rapidity from one end of the switchboard to the other, and thence gained the roof. The position and construction of the switchboard were evidently the weak points in the arrangements. The fire was raging fiercely behind it while only the front was easily accessible. The roof and the whole of the valuable contents of the dynamo room were entirely consumed. Owing chiefly to the massive nature of the structure the lower floor, containing the engines, although damaged, escaped destruction, and the adjoining boiler house has been only slightly affected. The resident engineer's dwelling rooms were, however, very severely damaged. The station was erected in 1888, and was opened in the following year. Amongst other precautions taken to minimise the communication of noise and vibration, the machinery rooms were placed in the central portion of the building, and have their own substantial walls, which are independent of the outer walls of the premises. The plant consisted of at least 10 Westinghouse alternate current dynamos, each capable of supplying 20,000 lamps. Each dynamo was driven by belting from its associated engine of 250 horse-power, the engines being also of the Westinghouse type.

Thwaite's Power Gas Plant.—A plan of the arrangement of the demonstration plant at Stoke Newington, which we described some time ago, appears in the *Engineer*. This demonstration plant, designed by Mr. Thwaite for the Motor Gas Syndicate, is very complete, and the drawings make the arrangement quite clear. Two analyses of gas produced from the cheapest slack coal are given, the one by Prof. Lewes, the other by Mr. Horace Allen. The first shows the result of low temperature with a blast of air and steam, and is as follows:—

Saturated hydro-carbon	4·10	per cent.
Hydrogen	7·33	„
Carbonic oxide	17·16	„
Inert residual	71·41	„
	100·00	

The second gives the result of high temperature working with air alone, and is as follows:—

Hydro-carbons	nil.	
Hydrogen	3·3	per cent.
Carbonic oxide	24·0	„
Inert residual	72·7	„
	100·0	

Of the residual inert gas not more than 4½ per cent. of the total production should consist of carbon dioxide, when a twin generator is working to best advantage, although with the single barrel producer it may sometimes reach 12 per cent. We believe that a gas engine using producer gas will work without false explosions or mis-fires, even with this high percentage of dioxide; but the lowest limit should always be aimed at for this constituent, if only for reasons of economy. The bulk of the residual inert gas is, of course, nitrogen, the presence of which is exactly proportionate to the bulk of oxygen required, and as the percentage of nitrogen increases with that of the carbon dioxide, this forms an additional reason for the use of the twin producer, from which it is so easy to obtain a gas low in dioxide.

Self-Propelled Road Vehicles.—*La Nature* publishes engravings of nine out of the 46 vehicles which were entered in the recent contest from Paris to Bordeaux and back, though only 28 finally presented themselves, and but 22 took a really effective part in the race. Only 11 got through to Bordeaux in the form they started, and but nine returned to Paris in less than 100 hours. These nine are illustrated, and eight of them are gasolene or petroleum motors and one, as before stated, was steam. The best run was that of the second prize vehicle which ran the 1,175 kilometres in 48 hours 48 minutes. *La Nature* has set down the performances of each of the nine vehicles in a chart from which the regularity of running can be read at a glance. All which made the entire journey show regular running except the steam carriage which arrived last of the nine and ran irregularly as far as Blois, 175 kilometres. It is stated that it is sufficient to carry 400 grammes (barely 15 ounces), of gasolene to produce one horse-power hour while the steam engine requires at least three kilogrammes of coal and 18 or 20 kilos. of water, and the electric carriage requires to carry more than 100 kilogrammes of load per horse-power hour. There can be but one opinion as to the best motive power for the road, namely gasolene. Steam and electricity demand too great a load for so rough a surface. The electric vehicle must seek its field in the smoothly asphalted streets of the city, where it can also best be refurnished with its necessary accumulators. With such results as have been accomplished by these French carriages it will surely not be long before the galling restrictions now placed upon self-motive vehicles in this country are removed. Any incompetent boor may drive a half broken horse when and where he likes, but an intelligent engineer may not drive that to which he is most accustomed, unless he will be content with a speed of, is it four miles per hour? and an *avant courier* bearing a red flag. You may see them in Kent and Sussex where so many traction engines are used. *Imprimis*, *Hobbinol* bearing a dirty rag that once was red, and behind him the slow moving engine that could scarcely overtake a broken down old tortoise even if it were pushed. Yet these traction engines have filled an important place. There are 7,000 of them at work it is said in the country, many of these in Kent and Sussex, doing work that ought to have been done by the two railway companies, who have almost bankrupted themselves and neglected the work at their own doors, or rather driven it away by exorbitant charges. With a good gasolene carriage and a speed allowance equal to that of a fast trotting horse, why should the commercial man and engineer be denied a pace that is allowed to the non-producing squire? There would be thousands of vehicles on the roads carrying travellers and perishable goods. These gasolene vehicles would pave the way for and compel the use of electrically propelled city carriages, as well as fostering the trade in small electric light apparatus for use by night on the gasolene engines. The present law as to power propelled vehicles is a disgrace to the statute book and will have to go.

Extensions at Portsmouth.—The Corporation are about to extend the street lighting system; for this purpose they are ordering 150 Brockie-Pell lamps and four Ferranti rectifiers, each rectifier to supply 50 12-ampère lamps. The lamp columns will have incandescent lamp brackets; it is proposed to fit each lamp-post with an automatic switch for turning on the incandescent lamps from the station. The switch is, we believe, supplied by Messrs. W. T. Glover and Co. With regard to the rectifiers, it is interesting to mention that the repairs bill for those which have been in use at Portsmouth for 14 months, is practically *nil*.

New Journal.—The first number (July) of a new monthly electrical journal, published at San Francisco, is before us. In their propaganda the editors pledge themselves to devote the columns of the *Electrical Journal* to the "industrial applications of electricity, gas and power," to make it a "strictly first class" publication, and to work in a field which they consider has been neglected by their American contemporaries. The first number contains an article of 14 pages on "Modern Telephone Exchange Systems," by Geo. P. Low, and several other interesting articles.

Electrically Operated Water Supply Plant.—For the water supply of De Kalb, Ill., a city of 3,000 inhabitants, the water has, until recently, been raised from a well close to a standpipe, by means of steam pumps, requiring the usual services of an engineer and attendant. When an electric system of lighting was inaugurated in the city, a proposition was accepted by the authorities to have the pumps run by the surplus current from the electric plant, and this system was completed and put in operation in February last. The water is raised from a well which is 900 feet deep, the water level being 65 feet from the surface of the ground, by a motor and lift pump, to a small supply reservoir just outside the pump house. From this reservoir it is taken by two large size Gould triplex pumps, and forced to the mains and standpipe, the latter being 18 feet in diameter, power being obtained from electric motors of high running speed, and geared down. The electrical plant is supplied with one double upright direct-attached 150 horse-power 50 kilowatt engine and dynamo, and two horizontal belt engines and dynamos, 100 horse-power combined, 25 kilowatt. The Edison three-wire system is used, and the connection to the pump-house is over a 0000 copper conductor. The requirements were for a constant level of water of 85 feet in the standpipe, with an increased pressure in the mains in an emergency of fire, the increase of pressure being obtained by use of an automatic closing valve at the standpipe when a fire pressure was required. An ordinary pressure of 40 lbs. is maintained in the mains for domestic service, and in case of fire the pressure is raised to 125 lbs. The pump-house is fully one-half mile from the electric plant, and the pumps are controlled entirely by means of a switch at the electric power house. The *Scientific American*, in a recent issue, described and illustrated the system which it says has been found to meet all the requirements.

The Telephone Committee.—The Select Committee appointed to consider and report whether the provision now made for the telephone service in local areas is adequate, and whether it is expedient to supplement or improve this provision either by the granting of licenses to local authorities or otherwise, have agreed to the following report: "Your Committee have examined numerous witnesses upon the matter referred to them, and have completed their evidence, but have not, in view of the approaching dissolution of Parliament, had sufficient time to consider their report. They have therefore agreed to report the evidence they have taken to the House, and to recommend that a Committee on the same subject be appointed in the next session of Parliament, to consider and report upon the evidence already taken, and, if necessary, to take further evidence.—*June 25th*, 1895."

Personal.—We learn that electrical engineers were well represented at the Amateur Athletic Championship held at Stamford Bridge Grounds, S.W., on Saturday, the 6th inst. The third and fourth places in the high jump championship being secured, respectively, by Mr. R. G. Perry, of Messrs. Crompton & Co., and Mr. W. E. Lane, of the Brush Company, both these gentlemen being awarded the standard medal of the Amateur Athletic Association.

We understand from a New York contemporary that Mr. A. E. Kennelly has received from the Western University of Pennsylvania the degree of D.Sc. in recognition of his work in the theory of cable faults, for his researches in magnetism and alternating currents, and for his application of complex qualities in alternating current work.

Metropolitan Gas Supply.—A *Gas* contemporary says that during the six months ended the 29th ult. Mr. W. J. Didbin, the superintending gas examiner to the London County Council, reported the illuminating power of the gas supply of the metropolis to be below the standard on 53 occasions. The Commercial Gas Company had 22 cases reported against it, the Gas Light and Coke 20, and the South Metropolitan 11. Our contemporary remarks that this is a strong argument in favour of a more reliable standard and a correct photometer. "Had these conditions been fulfilled, we venture to think that the 53 black marks would have been very materially reduced, if not altogether extinguished."

Petroleum, Spirit, and Gasolene.—*La Nature* draws attention to the differences between these products which are confused under the one name of petroleum, when speaking of the recent motor trials in France of self-propelled road vehicles. Crude petroleum is a viscous liquid, brown, but more or less tinged with green, and of a density varying according to its origin from ·700 to ·935 sp. gr. It splits up on distillation into a great number of products, of which three types, characterised by their density and flashing point, are actually used in the production of power by the aid of suitable motors. Lamp oil, or kerosene, has a density of ·800 to ·850, and a flashing point of 30° C. to 40° C. This is the oil that is but little dangerous when used in petroleum motors—properly so-called, yet little used. Spirit has a density of ·710 to ·750, and a flash point between 0° C. and 5° C. Gasolene has the still lower specific gravity of ·635 to ·690, and a flashing point of − 10° C. The combustible liquid used in the Paris-Bordeaux race, in all the motors, is a product of about ·700 sp. gr., and is an intermediate between spirit and gasolene. Petroleum motors are thus not strictly so-called. They are rather spirit or gasolene motors, and the distinction should be made, because the petroleum motor or oil engine, as we should call it in England, is a very much safer affair to run upon a road than a vehicle carrying even a small amount of low flashing point gasolene or spirit. The lighter liquids, no doubt, possess advantages in starting without delay that are not present in the true petroleum engine, which must be started by means of a lamp applied for some minutes to heat the exploder to the necessary high flashing point. Probably this advantage will retain the gasolene engine supreme on the road, but it will equally unfit it for the crowded street, where the smooth pavement will put the electrical vehicle an easy and safe first; for we cannot think that a volatile spirit will be permitted in the city, while the petroleum engine has the above disadvantage. The exhaust, too, of any fuel engine would alone unfit it for city use.

Obituary.—We regret to announce that Mr. J. B. Stearns died at Camden, Maine, U.S.A., on the 5th inst., aged 65 years. The deceased gentleman will be chiefly remembered in connection with the practical application of the duplex system of signalling in telegraphy. He showed how capacity could be added to the artificial circuit by means of condensers, in such a way as to successfully balance the static capacity of the line. This made the duplex system a practical and workable system. He visited this country in the early seventies, and the result was the adoption of his system of balancing by the Post Office Telegraph Department in 1873. By means of this the department was enabled to work long circuits as duplex circuits, whereas before it had only been possible to apply duplex working to short lines having small capacity.

We also regret to hear of the death of Rear-Admiral A. C. Curtis, which occurred the other day at Spithead, shortly after visiting the Italian fleet. He had served in the Black Sea and Baltic from 1854 to 1855, and in the Chinese War in 1860. He was promoted to commander for his laying the Atlantic cable in 1866, became captain in 1877, and served in that rank until he retired from the active list in 1890.

The Telephonic Sound Produced by Thermic Radiation.—Very recently in the *Comptes Rendus*, M. Semmola showed that on causing intermittent solar light to fall, by means of a lens, on the gilded metallic plate, 2 mm. thick, of a Hunnings microphone, the telephone put in circuit produces a slight but very distinct sound. If the luminous ray be suppressed, the sound ceases. The intensity of the sound increases or decreases according as the intermittences of the radiation become more or less rapid. The best radiations are the thermic radiations, as the sound is louder when the metallic plate is coated with lampblack. On the other hand, the sound is no longer heard when the luminous pencil traverses non-thermal substances before reaching the microphone. It is necessary that the tiny image of the sun which is formed in the focus of the lens, and which strikes the vibrating plate, should be fairly hot and capable of at least carbonising paper. It seems, then, that the plate suffers rapid and regular dilations and contractions which determine the thermic vibrations.

The Distribution of Moisture in a Steam Pipe.—Prof. Jacobus, to whose labours in this matter we have already alluded, has presented a paper on this subject to the Detroit meeting of the American Society of Mechanical Engineers. He states that after steam had passed through 8 feet of 3-inch pipe laid horizontally, over 95 per cent. of the moisture in it could be drawn from a ½-inch pipe, leading from the bottom side for quantities of moisture up to 8 per cent., and velocities as high as 25 feet per second, such moisture being thoroughly mingled with the steam previous to entering the pipe, though the apparatus was arranged so that the moisture entered near the top side of the pipe. Practically it nearly all fell to the bottom of the pipe in a flight of 8 feet. But the time required to fall across the 3-inch pipe is one-eighth of a second, and the horizontal velocity of the steam might be 64 feet per second, and still the water would reach the bottom. Various experiments were made, all pointing to the conclusion that the water in wet steam quickly reaches the bottom of the steam pipe, and can be almost entirely drawn off there by a simple half-inch pipe. It has long appeared probable that the ascertainment of moisture percentages was exceedingly fortuitous as conducted. If these experiments of Prof. Jacobus be correct, they are like a wet sponge passed over a goodly number of engine and boiler tests, whose records show moisture percentages to decimal places, but they also hold out some hope that, by a very simple arrangement of steam piping, the steam to an engine may be had practically dry. Further experiments are to be made, and in the meantime it would be desirable at least to lay very little weight on dryness coefficients obtained by ordinary means. So far as the experiments yet go, it would seem that we may hope to obtain fairly dry steam by catching off the water near the engine in a pocket let downwards from the steam pipe at the end of a length of pipe of sufficient length to allow gravity to act on the moisture, and this length is indicated as about three times what the actual steam velocity would point to be necessary for a given diameter of pipe, as to which we are promised further experiments.

Will Trunk Lines be Operated by Electricity?—In the *Engineering Magazine* for this month, Mr. Frank J. Sprague has an article on this topic. The concluding paragraph, which we thoroughly endorse, sums up the whole question :—"Let us lay aside, then, some of the visionary prophesies concerning electric railways. Perhaps no one has been more actively identified with them than myself; no one, I think, has greater faith in the future of the electric railway than I; but its future is not in the wholesale destruction of existing great systems. It is in the development of a field of its own, with recognised limitations, but of vast possibilities. It will fill that field to the practical exclusion of all other methods of transmitting energy; it will replace the locomotive on many suburban and branch lines; it will operate almost all street-railway systems and elevated and underground roads; it will prove a valuable auxiliary to trunk systems; but it has not sounded the death-knell of the locomotive any more than the dynamo has sounded that of the stationary engine. Each has its own legitimate field, which will play its proper part in the needs of all civilsation."

New Use for Old Insulators.—An American exchange says that on the wall of the office of the General Administration of Post Offices, Telephones, and Telegraphs at Brussels, there recently appeared a poster which announced a coming auction sale of second-hand insulators. The last paragraph reads as follows :—These articles will be sold in one or more lots to suit purchasers, and may be utilised for borders to parks and gardens.

NEW COMPANY REGISTERED.

Harrow Electric Light and Power Company, Limited (44,529).—This company was registered on July 5th with a capital of £25,000 in £5 shares, to take a transfer of all or any of the powers, duties, and liabilities, by the Harrow Electric Lighting Order, 1894, granted to and imposed upon the undertakers therein mentioned, and to supply electricity at Harrow-on-the-Hill, or elsewhere. The subscribers (with one share each) are:—J. G. C. Welldon, Harrow School, Harrow, head master; C. Colbeck, Harrow School, Harrow, assistant head master; E. R. B. Denniss, Harrow, barrister; R. C. Gibson, Harrow School, Harrow, assistant master; E. W. F. Steven, M.D., Harrow School, Harrow; T. S. Winkley, Harrow, tailor; A. P. Charles, Harrow, gentleman. The number of directors is not to be less than three nor more than seven; the first are C. Colbeck, E. R. B. Denniss, R. C. Gibson, E. W. F. Steven, M.D., and T. S. Winkley; qualification, £200; remuneration as the company may decide. Registered by R. E. H. Fisher, 19, New Inn, Strand.

CITY NOTES.

The Amazon Telegraph Co., Limited.

There seems to be a reasonable prospect that the Amazon Telegraph Company, the prospectus of which we publish below, will do a fair telegraphic business. It has the advantage of a board whose experience has been gained in South American telegraphs, and it is not too much to say that none can know better than they the volume of trade done on the route which will be traversed by the new cable. We do not anticipate many engineering difficulties in laying the cable, but it occurs to us that the maintenance may be considerable, and having regard to this fact, it is seriously open to question whether the £4,000 to be put aside for reserve fund, including repairs and renewals, will be sufficient. We are not suggesting for a moment that this point has been neglected by the directors, who are, one and all, Western and Brazilian Telegraph Company directors, and, no doubt, the question could be easily met. In spite of this, we consider that there is likely to be a fair business done by the new company. The dividends are not likely to be high, but we look upon the investment as a fair one.

The Amazon Telegraph Company, Limited.

This company has been formed with a capital of £250,000, divided into 25,000 shares of £10 each, payable, £1 on application, £2 on allotment, £2 10s. on September 16th, £2 10s. on November 15th, and £2 on January 15th, 1896. £17,125 annual subsidy is granted by the Brazilian Government for 20 years, payable quarterly in gold. The directors are to be—W. S. Andrews, Esq., Chairman; Lord Richard H. Browne; John Coppen, Esq.; C. W. Earle, Esq.; D. H. Goodsall, Esq.; Major Wood, Managing Director, who are the Chairman and Directors of the Western and Brazilian Telegraph Company, Limited.

The prospectus states among other things that the company is formed to connect by cable the city of Manaos, the capital of the State of Amazonas and chief emporium of the India-rubber trade in Brazil, with the important city of Pará (capital of the Pará State) at the mouth of the River Amazon, with intermediate stations or branch lines at Pinheiro, Mosqueiro, Soure, Cametá, Breves, Gurupá, Chaves, Macapá, Alemquer, Monte Alegre, Santarem and Obidos, in the State of Pará, and Parintins and Itacoatiara, in the State of Amazonas, as shown in the accompanying map.

At Pará the cable will join the land lines of the Brazilian Government and the Western and Brazilian Telegraph Company's cables connecting with the rest of Brazil and the Argentine Republic, and by the cables of the Brazilian Submarine Telegraph Company will be placed in communication with Europe and the telegraph system generally.

The Brazilian Federal Government, duly authorised by Congress, has granted a concession, embodied in a contract dated April 29th, 1895, and made between the Federal Government of the United States of Brazil and Richard J. Reidy, which includes the following important privileges:—

(*a*) Exclusive cable rights in the River Amazon for 30 years in the zone comprised between the capitals of the two States of Pará and Amazonas. (*b*) Annual subsidy of £17,125 during first 20 years of concession, payable quarterly in gold. (*c*) All favours granted to similar enterprises in Brazil. (*d*) Permission to enter into agreements with the Governments of the States of Pará and Amazonas for the establishment of other branch cables. Any subventions or favours granted by these Governments will take effect without prejudice to the subsidy or other favour conferred by above concession.

At the expiration of 30 years the system will revert to the Federal Government. The Government have also power of purchase after 10 years, at a price based on the value of the works and the average of profits for the preceding five years, but in no case less than the amount of the capital actually expended by the company for the laying down and working of the telegraphic cables.

A contract, dated July 5th, 1895, has been made between the company and Messrs. Siemens Bros. & Co., Limited, for the construction and laying of the cables, and provision of apparatus, repairing machinery, &c., and transfer of the concession to the company, for £211,000; the system will thus be handed over complete and ready for work. The specification has been approved by Messrs. Clark, Forde & Taylor, the engineers and electricians to the company, under whose supervision the cables will be manufactured and laid.

The total length of the cables will be about 1,365 miles, and by the

terms of the contract they are to be completed and laid by or before March 1st, 1896.

The value of the export trade of the Amazon Valley, according to the Government returns, forms one-fifth of the total amount of that from the Brazils, which aggregates £35,000,000 per annum; while the exports and imports combined of the States of Amazonas and Pará are estimated to be over 15 per cent. of the total trade of Brazil.

Some estimates are given of the probable business to be done, and the cost of working.

The number of international and internal words exchanged by and within Brazil at present is about 22½ millions per annum.

The experience of telegraph companies shows that telegraph traffic ordinarily follows the proportion of the trade.

The proportion due to the trade of the States of Amazonas and Pará as above stated should be over 3,000,000 words instead of 725,000. A very large development of telegraph traffic may therefore be confidently expected to flow from this extension of the telegraph system to the sources of traffic in the State of Pará and the Amazon Valley.

If, however, a telegraphic traffic equalling only the amount of the traffic of 1894, of the single City of Pará, be computed as a probable initial result from the laying of these cables from Pará to Manaos, and the 14 intermediate stations, all of them ports of call, and therefore places of trade and commerce, the gross revenue therefrom has been estimated at £36,250

Add Government subsidy		17,125
		£53,375
Deduct—		
Working expenses, say	£16,000	
Amortisation fund to redeem the capital in 30 years	5,694	
Reserve fund, including repairs and renewals, estimated at	4,000	
		25,694
Net revenue		£27,681

Or over 10 per cent on the capital.

The United River Plate Telephone Company, Limited.

Mr. J. Irving Courtenay presided at an ordinary general meeting of this company at Winchester House on Tuesday last. In moving the adoption of the report and accounts for the year ending March 31st, he said: I have much pleasure in congratulating the shareholders upon the improved position of the company, and in finding that the expectations I ventured to set forth at the meeting last year have been, to a fair extent, realised, so that the directors feel justified in recommending a dividend of 3 per cent. on the ordinary share capital. The condition of affairs in the Argentine Republic is a subject of such interest to so many people in this country, as to occupy a large space among the topics which are discussed with intelligence and thoroughness in the daily and weekly Press, and upon which you all thus have a full opportunity of forming an opinion. The advices from the company's representatives in the River Plate point, in spite of frequent fluctuations, to a distinct general improvement in business there. The tendency in all directions is towards a permanent improvement; but we must not shut our eyes to the hindrances there are to a rapid return of prosperity, especially the existence of an enormous amount of paper money. The depreciation of this paper is, as the accounts testify, a source of serious loss to our company; but we must face it, and deal with the position as best we can. The collections for the year under review, £149,262 2s. 9d., are the largest we have ever had for a similar period, and, taking everything into consideration, cannot but be deemed to be most encouraging. The number of subscribers has increased from 5,363 to 5,798 on March 31st last, and the increase continues. Upon this point Mr. C. H. Krabbé, one of our consulting directors in the River Plate, writes:—"Every day the telephone is becoming more of a necessity and less of a luxury; and so we go on getting a very satisfactory and steady increase in subscribers, and I see no reason why this should not go on in the future." I said, when I addressed you last year, that we must be prepared for a substantial increase in working expenses. There has been an increase in many items of expenditure, but the bulk of it is due to a general rise in wages. The increase of subscribers has caused a larger amount of work, and has necessitated a corresponding increase in the number of electricians and linemen. In the construction and maintenance department our force has been extremely busy, and considerable modifications, alterations, and repairs have been made to our plant and wayleads. Constant repairs and alterations are rendered necessary by the building operations that are in progress. The severe storms, more particularly those of October 16th, January 5th, and March 25th, did a great deal of damage to our wayleaves, and caused a large sum to be spent upon repairs. The repair of the La Plata plant has been the most important work in the maintenance department; in fact, we are building entirely new La Plata lines, and other important suburban work is in course of execution. The general condition of the branch offices is satisfactory. We have had to increase the capacity of the switchboards to keep pace with the increase of subscribers. This increase has been especially great at the central office, and has made the work there very heavy. Our employés have been called upon to exert themselves to the utmost, and have done so willingly and with excellent results. Especial commendation is due to our general manager in the River Plate, Mr. Chappell, and his able assistant, Mr. Parker. The progress of the Province of Buenos Ayres Telephone Company, in which, as you see from the balance-sheet we hold a considerable share interest, is reported to be quite satisfactory. As in previous years, the directors have transferred the sum of £3,000 standing to the credit of the depreciation and renewal fund to the credit of cost of conversion of 7 per cent. debentures and issue of 5 per cent. debenture stock; reducing the balance of that account to £14,209 13s. 8d. The investments are taken at cost, which is less than their present market value. The liability on bills receivable discounted, viz., £4,000, does not now exist, as the bills have run off in due course. I have briefly called your attention to the various matters that appeared to me to deserve comment, and I now move that the report and accounts submitted to the meeting be and are hereby received and adopted by the company, and the company declare a dividend of 3 per cent. on the share capital of the company for the year ending March 31st, 1895, payable on the 10th inst.

Mr. Frank W, Jones and Mr. Alfred Le Rossignol were re-elected directors, and the auditors were also re-elected.

A vote of thanks was passed to Mr. Chappell, the general manager of the company in South America, his assistant, and the staff, for their ability and zeal with which the business had been carried on during the past year.

A vote of thanks to the chairman concluded the business of the meeting.

National Telephone Company, Limited.—The directors have resolved, subject to final audit, to recommend at the forthcoming general meeting of shareholders, the following dividends for the half-year ended June 30th last. At the rate of 6 per cent. per annum, less income-tax, on the amounts paid up on the first and second preference shares; at the rate of 5 per cent. per annum, less income-tax, on the amounts paid up on the third preference shares; and at the rate of 5 per cent. per annum, free of income-tax on the amounts paid up on the ordinary shares, carrying £35,000 to reserve, and about £3,000 forward. The transfer books of the company will be closed from the 13th to the 26th instant, both days inclusive, and the dividend warrants will be posted on the latter date.

Southampton Electric Light and Power Company, Limited.—The reduction in the price of current, which we notified last week, is from 8d. to 7d. per Board of Trade unit, as from July 1st, 1895. A further reduction will be made for all units consumed over and above 20 units per 8 C.P. lamp fixed per annum to 4½ per unit. For the calculation for the half-year ending December 31st, 1895, 10 units will be taken as the minimum consumption for every 8 C.P. lamp fixed, and for future calculations a year will be taken as commencing on January 1st only.

Stock Exchange Announcements.—The Stock Exchange Committee has appointed special settling days as under:—Thursday, July 11th.—Royal Electric Company of Montreal—£120,000 4½ per cent. 20-year first mortgage debentures, Nos. 1 to 1,200. Wednesday, July 17th.—British Aluminium Company, Limited—11,303 7 per cent. cumulative preference shares, Nos. 1 to 11,303; and ordered the debentures (£120,000) of the Royal Electric Company of Montreal to be quoted in the Official List.

The Direct United States Cable Company, Limited.—The board have resolved to recommend a final dividend of 2s. per share, free of income tax, such dividend to be payable on and after the 31st inst., making, with the interim dividends already paid, 2 per cent. for the year ending June 30th last, and after placing £7,000 to reserve fund account, carrying forward a balance of £1,410 0s. 9d. The transfer books of the company will be closed from July 15th to the 30th (both days inclusive).

Eastern Extension Telegraph Company.—Notice is given that the interest on the 4 per cent. mortgage debenture stock for the half-year ending July 31st inst. will be paid by warrant on August 1st. The 4 per cent. mortgage debenture stock register will be closed from the 27th to the 31st inst., both days inclusive.

Chelsea Electricity Supply Company, Limited.—The directors have declared an interim dividend on the 6 per cent. preference shares, at the rate of 6 per cent. per annum, for the half-year ending June 30th.

Globe Telegraph and Trust.—A further distribution of 3s. 3d. per share is announced on the ordinary capital, leaving about £1,200 to be carried forward.

Cape Town and Suburban Electric Lighting Syndicate.—The payment is announced of a dividend of 7 per cent.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending July 7th, 1895, amounted to £915; week ending July 8th, 1894, £879; increase, £36; total receipts for half-year, 1895, £915; corresponding period, 1894, £879; increase, £36.

The Great Northern Telegraph Company. The traffic receipts in June, 1895, were £25,200; January 1st to June 30th, 1895, £149,200; corresponding months, 1894, £129,800; corresponding months, 1893, £132,800.

The Liverpool Overhead Railway Company. The receipts of this railway for the week ending July 7th, 1895, amounted to £1,250; corresponding week last year, £917; increase £333.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 5th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brasilian Telegraph Company, Limited, were £2,969.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, July 3rd.	Closing Quotation July 10th.	Business done during week ended July 10th, 1895. Highest.	Lowest
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	101 —104 xd	102 —105	103⅜	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	47 — 49	47 — 49	...	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	88 — 89	88 — 89	89	88
2,993,560£	Do. do. Defd.	Stock	...	...	...	8¼— 8⅝	8¼— 8⅝	...	...
130,000	Brazilian Submarine Teleg., Ltd.	10	6¼% §	6¼% §	...	13 — 13⅛xd	13⅛— 13⅜	13⅛	13⅛
75,000£	Do. do. 5 %, Debs., 2nd series, 1906 ...	100	5 %	5 %	...	110 —114 xd	110 —114	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	10% ‖ §	... §	...	3 — 4	3 — 4	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	165 —170 xd	160 —165	...	...
224,850	Consolidated Telep. Const. and Main., Ltd. ...	10/-	2 % §	2 % §	1½%	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14	13½	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20 — 21	20 — 21	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½— 4½	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	9¾— 10¼	9¾— 10¼	9⅞	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	...	4½%	103 —106 xd	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	3½% §	2⅝% §	2 %	9½— 9⅝	9½— 9⅝	9 11/16	9½
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	...	16⅝— 16⅝	16⅝— 16⅞	16¾	16½
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 % §	...	17½— 17⅝	17½— 18	17⅝	17½
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	106 —109	107 —110	...	...
1,237,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	123 —126	124 —127	126	125
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17 — 17½	17½— 17½	17⅝	17
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	102 —106 xd	102 —106	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	103 —106 xd	103 —106	103⅜	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	124 —127	124 —127	...	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	102 —106 xd	102 —106	103	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	103 —106	103 —106	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	107 —110	107 —110	108½	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	111 —114%	111 —114%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅞% §	4⅞% §	4¼%	10 — 10½	10⅛— 10⅜	10⅜	10⅛
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 %	16¾— 17	17 — 17½	17 3/16	16⅞
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	8⅜%	21¾— 22¼xd	21⅞— 22¼	21⅛	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	105 —108	105 —108	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	49 — 52	49 — 52	51½	50½
37,548	London Platino-Brazilian Teleg., Ltd.	10	2 %	2½%	1½%	5 — 7	5 — 7	...	...
100,000£	Do. do. 6 % Debs.	100	6 %	6 %	6 %	106 —110	106 —110	...	...
28,000	Monte Video Teleph. Co., 6% Pref., 1 to 28,000	5	*nil*	4 %	...	1½— 2½	1½— 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 % §	5 %	5⅜— 5⅞	5⅜— 6	6	5 1/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	15½— 16½	16 — 17	17	16
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	14½— 15½	14½— 15½	15	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	...	5⅛— 6⅛	5⅛— 6⅛	6 1/16	...
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	...	105 —107 xd	105 —107	105½	105
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	4½%	1/16— 1/8	1/16— 1/8	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	105 —108	106 —109	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	*nil*	3½— 4½	3½— 4½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	124 —129	124 —129	127	125
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2 — 3	2½— 3	2⅝	2 7/16
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	92 — 97 xd	92 — 97	94½	94
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	...	...	4½— 5½	4½ — 5½	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	102 —105	103 —106	104½	103½
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1½— 2½	1½— 2½	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	98 —103 xd	98 —103	100⅜	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3 %	10½— 11	11 — 11½	11½	10⅜
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6¾— 6⅞	6¾— 6⅞	...	...
33,129	Do. do. do. Def. Ord.	7½	...	...	1 %	4½— 4⅝	4¾— 5	4 15/16	4⅜
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	103 —107	104 —108	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	103 —107	104 —108	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅞%	¼%	⅜— 1	⅜— 1	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	9½— 10½	9¼— 10¼	10½	10
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	8½— 9⅛	8½— 9⅛	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	109 —112 xd	109 —111	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	113 —118	113 —118	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	102 —104	102 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5½— 5⅝	5½— 5⅝	5⅝	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	14½— 15½	15 — 16	15½	15⅛
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16 — 16½	16 — 17	16 13/16	15 15/16
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	131 —134	131 —134	131	...
200,000	Do. Prov. Certs. all pd. (iss. at £28 pm. all pd.)	...	...	...	...	131 —134 xd	131 —134	...	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	9 — 10	9 — 10	...	...
10,000	Do. do. do. 6% Pref., £4 pd., 40,001—50,000	10	...	...	...	4 — 4½	6 — 6½	...	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5½%	7⅜— 7⅝	7⅜— 7⅝	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2 %	2½%	3 %	10½ — 11	10½— 11	10 13/16	10 3/16
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	115 —117	115 —117 xd	117	116½
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	8 — 8½	8¼— 8⅜	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	4½%	6½%	8¼— 8⅜	8¼— 8⅜	8⅜	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 9½	9 — 9½	...	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	7⅞— 8¼	7⅞— 8¼	8 1/16	7⅞
8,000	Do. do. do. Ord., 60,001 to 68,000 ...	5	...	...	...	7½— 8	7½— 8	...	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‡ Dividends paid in deferred share warrants, profits being used as capital

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, July 3rd.	Closing Quotation, July 10th.	Business done during week ended July 10th, 1895. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	6 % §	6 % §	...	2½— 2⅝	2¼— 2½	2½	2 3/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	6 % §	...	2⅜— 2⅝	2½— 2⅝	2½	2⅛
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	112 —115	112 —115	113½	...
630,000*l*	City and South London Railway	Stock	⅝%	⅝%	1¼%	42 — 44	42 — 44	...	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	...	2 — 2½	2 — 2½	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	...	...	...	1⅜— 2¼	1⅜— 2¼	...	...
100,000	Do. do. do. 4½% Deb. Stock Red....	Stock	...	...	...	104 —107	104 —107	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	...	¾— 1	¾— 1	1 1/16	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	1⅞— 2¼	1⅞— 2¼	2	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	1 — 1½	1 — 1½	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	1⅛— 1⅜	1 — 1¼	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	¼— ⅜	¼— ⅜	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½— 7½	6½— 7½	...	...
7,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	6 %	10½— 11½	10½— 11½	11½	11
3,000	Do. do. do. 7% Pref.	10	...	...	...	14 — 15	14 — 15	14⅝	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	...	104 —107	104 —107	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	20 — 22	20 — 22	21⅛	20
200,000*l*	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	102 —104	102 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	9 1/16— 10 1/16	10 — 10⅛	10 1/16	...
6,295	† Do. do. Pref., £10 paid	10	...	5 %	5 %	14¾— 15¼	14¾— 15¼	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	43 — 45	43 — 45	44⅞	43½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107 xd	104 —107	...	...
54,000*l*	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	4⅜— 4⅝	4⅜— 4⅝	4⅝	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—6%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅞—6¼.
Chelsea Electricity Supply Ord., 6¾—7.
Do. do. do. Pref., 7—7½.
Electric Construction Corporation, 6 % Debentures, 84—87.
House-to-House Company (£5 paid), 4—4½.
Do. do. 7 % Preference, of £5, 8—8½.
Do. do. 4½% Debentures of £100, 108—110.
Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 7½—8; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.
Liverpool Electric Supply, £5 (fully paid), 7½—7¾.
London Electric Supply Corporation, £5 Ordinary, ⅜—⅝.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 5⅞—6¼.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

TESTS OF A COMBINED ELECTRIC LIGHT AND ELECTRIC RAILWAY CENTRAL STATION.*

By DUGALD C. JACKSON and ARTHUR W. RICHTER.

The central station of the Four Lakes Light and Power Company supplies the power for the electric lighting of Madison, Wis., and also supplies power for the Madison City Railway. The station is situated on the bank of Lake Monona, in a fairly central location (fig. 1).

The boiler-room contains two return tubular boilers, rated at 110 horse-power each, and one Stirling boiler of 200 horse-power capacity. The engine-room is equipped with three Russell compound engines, two Davidson jet condensers, and two Davidson feed-pumps.

Engine No. 1, 380 horse-power capacity, is belted to the main shaft, from which are run four Thomson-Houston arc light machines, each of which has a capacity of 50 1,200-candle-power lamps, and one Westinghouse alternator of 750 lights capacity. Two other alternators, a Slattery and a Thomson-Houston, are also installed but are to be removed.

Engine No. 2, 190 horse-power capacity, is used for running the railway generators. These are two 90 K. W. General Electric machines of 500 volts, 180 amperes, speed 650, and are belted tandem fashion from the fly-wheel of the engine. A third tandem belt from the same fly-wheel runs over a clutch pulley on the main shaft, and the shaft can therefore be driven from this engine when desired. The two generators are connected to the same bus-bars, and supply power for the operation of the Madison Street Railway, and for a number of stationary motors which are connected to a special power circuit run out from the bus-bars. Both of the above engines are connected to one of the Davidson condensers.

Engine No. 3, 400 horse-power capacity, is directly connected to a 300 K. W. "Monocyclic" alternator, and condenses into another Davidson condenser and air-pump. The alternating current output of the station is used exclusively for incandescent lighting.

Engine Dimensions.

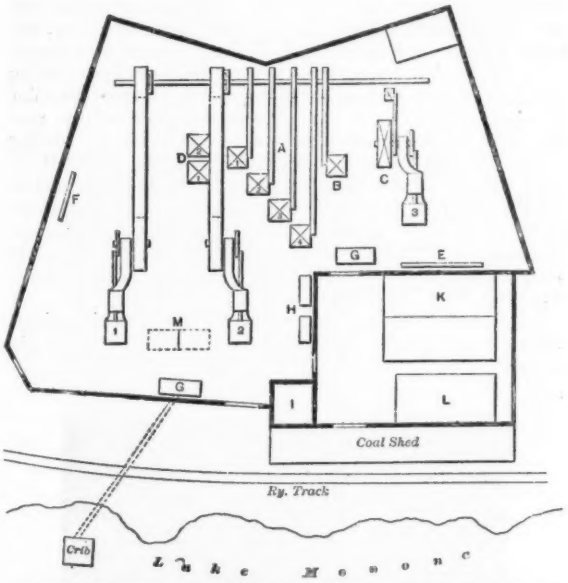
Nos. 1 and 3.
Stroke, 24 inches.
Diameter of high-pressure cylinder, 15 inches.
Diameter of low-pressure cylinder, 24 inches.
Diameter of high-pressure piston rod, crank end, 3 inches.
Diameter of high-pressure piston-rod, head end, 2⅜ inches.
Speed, engine No. 1, 134 revolutions per minute.
Speed, engine No. 3, 152 revolutions per minute.

No. 2 railway engine.
Stroke, 20 inches.
Diameter of high-pressure cylinder, 13 inches.
Diameter of low-pressure cylinder, 20 inches.
Diameter of high-pressure piston-rod, crank end, 2⅜ inches.
Diameter of high-pressure piston-rod, head end, 2¼ inches.
Speed, 133 revolutions per minute.

The station is operated by one engineer and one fireman from midnight until noon, and by one fireman, one head engineer, and one assistant from noon until midnight, and one oiler from 6 p.m. until 12 p.m., making a total of six station employees for the 24 hours' run. Each 24 hours during the week, current is furnished to the electric railway and power circuits for 17·5 hours, and to the alternating current circuits for 23·5 hours, except on Sunday, when the alternators are shut down for an additional 12 hours. Current for arc lighting is supplied principally between the hours of dusk and midnight, though certain arc-light circuits are operated all night.

* Presented at the Detroit meeting (June 28th, 1895) of the American Society of Mechanical Engineers, and forming part of Volume xvi. of the *Transactions*.

This station is one of that type, so well known to electrical engineers, which has grown to considerable proportions from a small and poorly conceived beginning, and which therefore may be said to suffer through its own growth. During the past two or three years it has been quite thoroughly overhauled, and its physical condition has been greatly improved, but only at the expense of a considerable addition to the capital account. The results of the test which are given may be taken to represent



A, Arc light dynamos; B, Westinghouse alternator; C, Monocyclic alternator; D, Railway generators; E, Electric light switchboard; F, Electric railway switchboard; G G, Condensers and pumps; H, Feed pumps; I, Oil room; K, Return tubular boilers; L, Stirling boiler; M, hot wells; 1, 2, 3, Russell engines.

FIG. 1.

results fully equal to those obtained by the average electric station in our cities of the smaller size. (Madison has 15,000 inhabitants.) This statement will doubtless be viewed with surprise by the numerous members of this society who are experts in steam engineering, and who carry continually before their eyes the remarkable economy obtained in pumping plants, but that the statement is fully borne out by the facts will be affirmed by every electrical engineer of experience.

The object of the test recorded in this paper was to determine the efficiencies of the boilers, engines, and generators under actual operating conditions, nothing having been done either before or during the test to change the conditions from those occurring in the regular daily run. All the data required was obtained and recorded entirely independently of the regular employees, who were required to attend to the operation of the station, exactly as is done day after day and week after week. A trial test of four hours' duration was made beforehand, in order to familiarise the observers with their work and to ascertain whether all the arrangements were well conceived. All reasonable precautions were used to make the data obtained reliable, and all instruments were supplied from the laboratories of the University of Wisconsin, and were compared with the laboratory standards. All electrical instruments used were calibrated by means of a Kelvin standard balance. The steam-pressure gauges and indicator springs were standardised by comparison, while hot, with a mercury column. The scales, thermometers, &c., were tested for accuracy by comparison with proper standards.

The test began at 6 a.m. Monday, when the engines started up for the day, lasting until 5.30 a.m. Tuesday, when the engines stopped for their half-hour breathing spell, and may be considered successful, as nothing more serious than the occasional breaking of an indicator cord occurred to interfere with the results. Four of the observers, one having general supervision of the test, another overseeing the weighing of the coal, another the weighing of the water, and a fourth having charge of the calorimeter tests, were on duty through the entire run. These four men, Messrs. Burgess, Frankenfield, Mead and Crane, were members of the senior class in electrical engineering in the University of Wisconsin, and handled their work excellently. They were assisted by a certain number of experienced student observers, about twenty in all, who were required to read the various ampèremeters and voltmeters, take indicator cards, &c. The test was generally supervised by two of the assistant professors of the university. During the whole of the test the station presented no confusion, but was operated with the usual systematic regularity.

(To be continued.)

THE PHYSICAL PROPERTIES OF MANGANESE STEEL.

When Mons. H. Le Chatelier publishes the results of those investigations in metallurgy which he is constantly making, he always enriches our knowledge as well as the literature of the subject. Compared with many workers, the number of papers which he publishes are few, but, perhaps, partly because of that, they always carry weight. Some of his recent researches have been concerned with the physical properties of manganese steel, and are to be found described by him in the *Comptes Rendus*, cxix., p. 272.

The paper opens with a recapitulation of the properties of the best known form of manganese steel, viz., that containing 13 per cent. of manganese. This alloy is non-magnetic and possesses the highest electrical resistance of all the alloys of iron—about 1 ohm for wire 1 m. long and 1 mm. in diameter. Mr. Hadfield, however, has lately discovered the existence of what the chemists call an allotropic modification of this alloy which possesses some strikingly different properties, amongst which the most notable is that it is magnetic; and this new alloy is the subject of the present investigation.

The magnetic form of manganese steel was obtained by annealing the non-magnetic alloy at a high temperature for about 10 days. It appears that the transformation is effected at 500—650° C., and that the operation is complete in one or two hours, the most favourable temperature found by Le Chatelier being 550° C. To reverse the change the alloy is heated to a temperature not lower than 800° C., and cooled rapidly enough to prevent alteration to the magnetic variety.

The following table gives the variation of the electrical resistance with alteration of temperature, for the two allotropic modifications of manganese steel :—

Electrical resistance of a wire 1 m. in length and 1·4 mm. in diameter.

Temperature in degrees Centigrade.	Non-magnetic alloy. Resistance in ohms.	Magnetic alloy. Resistance in ohms.
15°	1·06	0·88
90°	1·19	0·99
300°	1·44	1·27
500°	1·65	1·50
635°	...	1·70
730°	...	1·79
850°	1·88	...
965°	...	1·93
1,020°	1·97	1·97

The two curves of electrical resistance meet at about 740° C. and become identical for higher temperatures, this temperature is that at which pure iron passes from the magnetic to the non-magnetic state. This leads to the hypothesis that manganese steel is a mechanical mixture of iron and a definite compound of iron and manganese which would not be magnetic. If this assumption be permissible it is clear that the iron would undergo its ordinary change with rise of temperature; but the rate of change would be retarded by the presence of the manganese compound. This paper also contains some data and other information respecting the dilation of manganese steel with rise of temperature.

EXPERIMENTS ON THE RELATION OF HYSTERESIS TO TEMPERATURE.*

By FRANK A. LAWS and HENRY E. WARREN.

(*Concluded from page* 5.)

Owing to the manner in which the specimen is constructed, the area included in the B winding is but partially occupied by the iron. In calculating the approximate values of B no allowance has been made for this, as the permeability is high in the cases where B has been determined. If observations were taken at temperatures where the permeability was very low, it would be necessary to apply a correction for this unoccupied area. The values of B were calculated by the formula

$$B = \frac{E^1 R D}{20 A N n R^1 D^1}.$$

D is the deflection corresponding to the value of B to be found. R is the resistance in circuit, R h; N, the number of turns on B winding. n, the number of revolutions per second. A is the area of the iron included in the B windings. D^1 is the deflection of the galvanometer when an E.M.F. of magnitude, E^1, and a resistance, R^1, are inserted in the circuit, R h, the dynamo turning at the normal rate.

The furnace used for heating the specimen was built of fire brick, the external diameter was about 36 inches, height 18 inches. Inside the fire brick was a layer of asbestos wool 2½ inches thick, kept in place by asbestos board, which was protected by thin sheet iron. The box containing the specimen was made of asbestos board about 1½ inch in thickness, and lined with retort cement. During the tests it was tightly closed. The furnace was heated by three blast jets made of gas pipe, the external tubes were ¾ inch inside diameter, the inner tube ⅜ inch. The supplies of gas and air were regulated by slide valves. The jets were directed into the furnace tangentially, and with a slight upward inclination, the effect being to establish a good circulation and keep the interior of the furnace at a uniform temperature.

The specimen upon which the following tests were made was composed of so-called French steel, which showed, on analysis, the following impurities:—

Manganese	0·535	per cent.
Phosphorus	0·013	„
Silicon	0·085	„
Sulphur	0·018	„
Carbon	0·970	„

The mass of iron employed was 628 grammes. From this material, which was four $\frac{1}{1000}$ths of an inch thick, rings of 3 inches outside and 2 inches inside diameter were stamped, and the specimen formed by piling them. Each was insulated from its neighbours by a layer of pipe clay, applied as a sort of paint, the clay having been moistened with alcohol. Every tenth layer was insulated with mica. The pile so formed was wrapped with asbestos cloth, and the magnetising coil of 36 turns of No. 14 copper wire wound on. The wire was insulated by winding it with asbestos twine. Interwound with the magnetising coil was the B coil of 24 turns. These two windings formed on the outside of the specimen a single layer. The temperatures were determined by a Le Chatelier pyrometer, calibrated by known melting points. The hot junction was placed inside the asbestos wrapping resting against the iron, the leads were brought out through the usual double-cored fire clay tube; this was surrounded by a piece of gas pipe thoroughly wrapped in asbestos cloth, because in using this pyrometer in a case like the present, where the leads pass from the hot junction through a space at a higher temperature at a short distance from the junction, it is necessary to guard against conduction along the leads, and consequent errors in the temperature.

The manner of making the tests and the subsequent calculation was as follows:—Owing to the construction of the furnace, the specimen being well shielded from the heat of the flames by the internal chamber, the air insulation, and its own asbestos covering, the temperature of the iron rises gradually; consequently the specimen will be at very nearly a uniform temperature. When a reading is desired, the alternating current is turned on, and the B deflection adjusted to its maximum value by K^1, and to its correct numerical value by varying the magnetising current. Watt-balance resistance, r_1, is now adjusted, and the pyrometer reading corrected for zero, and dynamometer reading and time observed; after a few minutes the observations are repeated, the temperature having risen in the mean time. This process is kept up until the iron loses its magnetism. Occasionally, a direct current was sent through the apparatus and the watt-balance, dynamometer, and pyrometer readings taken; these allow the value of r_1^1 in the hysteresis formula to be determined by making a plot, the co-ordinates being watt-balance and pyrometer readings, from the plot the value of r_1^1, corresponding to any pyrometer reading may be read off. The electro-dynamometers were calibrated by sending a direct current through them, and measuring the P.D. at the terminals of a known resistance by projection against the E.M.F. of a Clark cell; the values of deflections and currents squared were plotted, giving straight lines. I^2 was determined by reference to these plots. The zero errors of the dynamometers employed were very variable, and were determined after each reading.

The results of the measurements will now be given. They are plotted as referred to at the beginnings of the several tables.

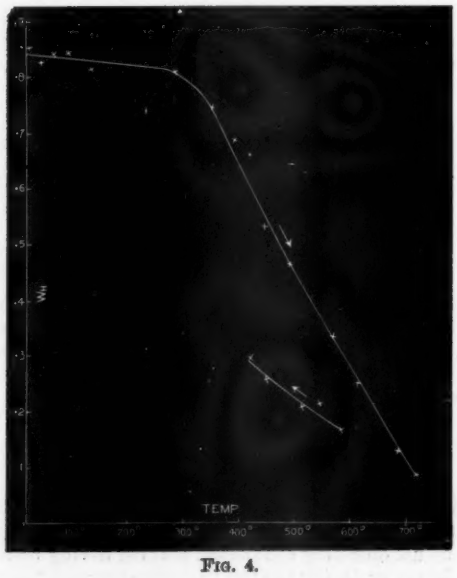


Fig. 4.

Table I.—First Heating: Ascending Curve.

See Figure 4.

B = 1,970. n = 125. w_h = Hysteresis loss in specimen.

w_h.	Temp.	w_h.	Temp.
·852	23°	·678	387°
·834	45°	·526	440°
·845	67°	·456	481°
·845	98°	·331	546°
·817	132°	·241	595°
·809	181°	·130	672°
·818	272°	·083	709°
·742	347°		

The specimen lost its magnetic properties so rapidly that further measurements could not be taken on the ascending curve.

Table I.—Descending.

w_h.	Temp.
·0	787°
·161	576°
·206	503°
·255	445°
·290	417°

Power shut off.

* Contributions from the Physical Laboratory of the Massachusetts Institute of Technology. Presented by Charles R. Cross to the American Academy.

Table II.—Second Heating: Ascending.

See Figure 5.

B = 1,974. n = 125.

W_A.	Temp.	W_A.	Temp.
·516	20°	·149	632°
·520	75°	·121	653°
·519	108°	·115	662°
·522	160°	·093	679°
·440	269°	·083	688°
·407	310°	·094	692°
·378	345°	·104	693°
·340	397°	·130	693°
·321	423°	·130	693°
·311	438°	·142	693°
·293	470°	·144	693°
·258	511°	·142	692°
·228	555°	·144	694°
·167	593°		

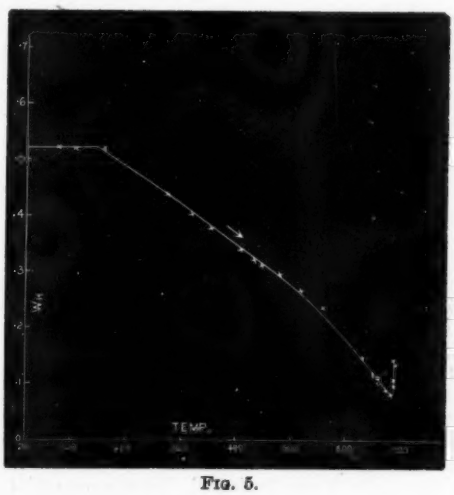


Fig. 5.

Inspection of the plots shows (figs. 4 and 5) that for this sample of steel a moderate elevation of temperature up to about 270° has but a small influence on the hysteresis loss; that at this point a change takes place, and the diminution of hysteresis, with rise of temperature, is much more rapid, the decrease being such that at 675° the loss is but 13 per cent. of its value at ordinary temperatures. After heating above the inflection point, the specimen shows on cooling a marked decrease of the hysteresis loss from its value at the same temperature on the ascending curve. If the specimen be heated again, a change of direction of the curve takes place, but at a lower temperature. The second plot (fig. 5) shows an increase of the hysteresis loss after the point of inflection has been reached. As only two heatings were made, we were unable to verify these observations, the results of which became apparent only when they were reduced. In addition to the experiment at high temperatures, the following observations were made. A specimen was made up and the loss measured at the ordinary temperatures; a mean of three measurements gave ·289 watts as W_A. The specimen was then covered with a mixture of solid carbonic acid and ether; a mean of three measurements showed W_A as ·288 watts, showing that there is practically no change of hysteresis for a diminution of temperature to about — 80°.

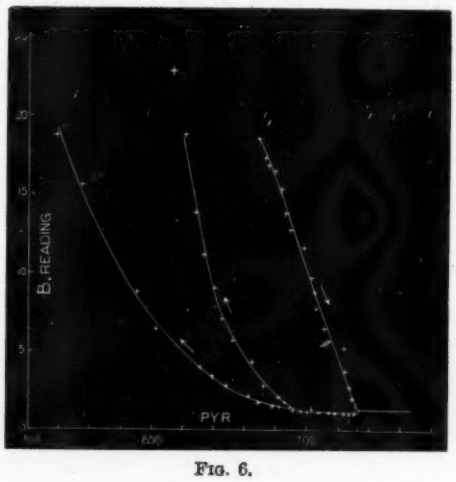


Fig. 6.

Between the ascending and descending observations of the second heating, readings were taken for the purpose of finding whether the temperature at which the iron becomes markedly magnetic on cooling is the same as that at which the sudden diminution of the magnetic properties occurs on heating. Simultaneous readings of the B galvanometer and pyrometer were taken, the current remaining constant, no adjustment for maximum was made. The readings, together with some from the descending curve of the first heating, are given below, and, after being corrected for zero, are plotted in fig. 6.

Table III.

First heating.		Second heating	
B Reading	Pyr.	B Reading	Pyr.
38·8	7·17	28·1	6·99
38 8	7·10	29·9	7·01
38 8	7·05	31·0	7·02
38·8	7 00	32 1	7 03
38·7	6·95	33·4	7·05
38·55	6 90	34·8	7·10
38·15	6·83	36·1	7·11
37·70	6·80	37·2	7·12
37·00	6·73	37·9	7·13

First Heating.		Second Heating.	
B Reading.	Pyr.	B Reading.	Pyr.
36·3	6·69	38·3	7·14
33·65	6·51	38·6	7·15
31·2	6 45	38·7	7·15
		38·6	7·19
		38·8	7·14
		38·75	7·10
		38·75	7·03
		38·7	7·01
		38·65	6·98
		38·55	6·95
		38·25	6·93
		37·85	6·90
		37·1	6·85
		36·5	6·84
		34·1	6·76
		32·7	6·73
		30·7	6·70

Fig. 6 shows that the two points do not coincide, that on the descending being about 12° lower than that on the ascending curve. The difference of form of the curves is noticeable, showing that the regaining of magnetic properties on cooling is more gradual than their loss on heating; the sudden exaltation of magnetic properties occurs at the same temperature in the first and second coolings.

At the time of this writing the research has not been fully completed. We are, however, now engaged on further experiments, and hope to present additional data in the near future.

Rogers Laboratory of Physics,

REVIEW.

Electrical Laboratory Notes and Forms. By Dr. J. A. Fleming. London: *The Electrician* Printing and Publishing Company, Limited.

This volume is unique in its way; it is a sure sign that what is now being done at University College, London, will in future be also attempted at many of the provincial colleges, technical schools, and at the Polytechnics in London and elsewhere. We have here a collection of facts, brief instructions as to the manner in which certain experiments are to be carried out and space provided for recording the results when they have been obtained in accordance with such instructions. The matter, however, of the book is wanting, it is left for the individual to supply; in fine, what Dr. Fleming has done has been to write an extended preface and leave it to each of those who read his introductions to write the rest of the book for themselves, each according to his beliefs, his ability and his own sweet will.

With the book as a whole, therefore, we have nothing to do; we certainly should like to review some of the productions which will be the outcome of this attempt to smooth the path of knowledge, but in our copy this is as yet blank but ruled paper. We must, therefore, confine our comments to Prof. Fleming's portion of the work.

This consists in having prepared some twenty "elementary" and an equal number of advanced laboratory forms, it being the intention that the practical instruction in the electrical engineering laboratory should be systematised. The student, therefore, will receive one of these forms at a time and be told to carry out the instructions thereby conveyed to him. He will find on it, first, a list of the apparatus required, secondly, a brief discussion of the theoretical principles of the experiment, and, thirdly, headed and ruled columns left blank in which he may enter the data obtained during the progress of his work. The idea is in some ways an admirable one, but it must tend to kill off the little remaining sense of independence and exercise of the imaginative and inventive faculty which yet remains to the aspirant for examinational honours. Admitting for the nonce that it is desirable that the time of both demonstrator and student should be husbanded as much as possible, let us see the kind of matter placed before the Freshman on entering the laboratory. As we have used these notes and forms for the routine work of students' practical classes, we may be permitted to speak with some authority on the subject.

The first form is entitled "The exploration of magnetic fields," and consists in taking observations along the axis of a coil. Unfortunately, this is much too difficult a subject to put as No. 1 in the elementary series, and it is hardly put clearly before the student what it is he is to try to prove or arrive at, otherwise the matter is good; a second part of No. 1 considers a permanent magnetic field. The magnetic field of a circular current forms the second experiment, and is an elaboration of the first. In dealing with the "Measurement of insulation resistance" the author in describing the connections for the ordinary direct deflection tests, says "A key should be inserted *between the battery and tank*." As a matter of fact such an arrangement would involve two extra leads being brought into the testing room, therefore this device is seldom adopted in practice. Although "it is generally usual to record the insulation resistance after *one* minute's electrification," readings for *two* minutes are almost invariably (or ought to be) taken and recorded so as to show the percentage of electrification. Dr. Fleming only casually alludes to the latter as if it were a matter seldom taken account of. The standard temperature is stated to be 70° F., which, of course, is wrong, it should be either 75° F. or 60° F., the former being used for submarine cables, the latter for electric light cables. In dealing with the "Determination of the capacity of a concentric cable" the author rather makes it appear as if a "ballistic" galvanometer were necessary for the purpose; as a matter of fact the ordinary Thomson, although not really a ballistic instrument, is (except under very rare conditions) sufficiently so for all practical purposes; we do not know, indeed, any cable factory where a true ballistic galvanometer is in existence, much less in use. The heading, "A complete report on a primary battery," would be more correct if the word "complete" were left out, as, although what is said is correct so far as it goes, it can hardly be considered to be a "complete report." "The determination of magnetic field strength" is based upon the preceding account of the ballistic galvanometer, it gives a fairly complete, but not at all simple explanation of the so-called ballistic method of measuring B. In No. 7, the formula $F = 2A/10\,d$ is given for the force at a distance, d, due to a very long straight wire carrying A amperes; this must be new to many students as giving the first step towards the definition of magneto-motive force ($4\pi A/10$). This experiment is a most useful one, and has a practical relationship to the solenoid and the electro-magnet. It is put to some service in the next form where the determination of the magnetic field in the air-gap of an electro-magnet is dealt with. The standardisation of a voltmeter by the potentiometer (E, 13) (A 5), of an ammeter (A 6) and the measurement of low resistances by the potentiometer (A 2., A 3.) are useful exercises with this handy instrument. It is interesting to note that Dr. Fleming, as the great apostle of the potentiometer, should have adopted the Crompton form in its entirety. The beginner learns, however, to use the slide wire as a calibrated scale of P.Ds. before taking up the elaborate equipments Mr. Crompton provides. In a photometric examination of an incandescent lamp, the observed C.P. is taken as the mean of measurements with plane of filament parallel, at angle of 45° and normal to the photometer disc. This is a happy medium between the whirling table and measurements in a single position. Good practically useful work is given in the determination of the absorptive powers of semi-transparent screens, and of the reflective powers of various surfaces. This is practically an order to repeat Dr. Sumpner's experiments, now frequently quoted.

The measurement of resistance by the Post Office pattern bridge is really an exercise on determining temperature coefficients in a rough way. The precautions given will assist the student to do as little damage as possible. We have always found that students either drop the plugs into their positions without securing proper contact, or else screw them home with quite superfluous energy. The determination of specific resistance of a wire is by no means an easy thing to do if accuracy be required, but the exercise as put by Dr. Fleming must be a useful one to a technical student. Incidentally it is mentioned that mass determinations have to be made with all the corrections necessary to ensure a reliable result. This is just the point too often forgotten in the electrical laboratory, and it is satisfactory to find attention called to it here. The same ought to be done with all temperature measurements, as Griffiths has shown that a mere reading of the height of mercury in a thermometer tube is not a measurement of temperature but merely one of the factors by which it can be determined. One of the advanced forms already referred to, deals with the measurement of insulation and high resistance. Dr. Fleming says that the "only one method which yields results which are perfectly satisfactory in practice is the method of testing insulation resistance directly by the current sent through the insulation by a known electromotive force." This is one of the least satisfactory set of instructions in the whole book. In the first place nothing is said which would convey to the student the routine of insulation testing as practised in a cable factory, for instance. The E.M.F. of the battery is *not* required to be known, as the "constant" of the galvanometer is taken through a high resistance (a megohm). We cannot help again remarking that we miss the column headed "Electrification between 60 and 120 seconds" which appears on all factory test sheets, and do not think the student who requires an electrostatic voltmeter in connection with an insulation test will be considered to know how the test should be made. Again, the insulation of a system of house wiring is generally held to be that of copper to earth and not from copper to copper of the two leads, if one test is given the other certainly ought to be also. The capacity test given is also a little removed from practice, and although the direct discharge method is mentioned it is dismissed as lacking in accuracy. As a matter of fact the vast majority of tests of capacity are taken in this way, it requires, however, that a definite period of "charge" should be given, and for this 15 seconds is generally taken on long cables. On this point nothing is said as to the real work of capacity testing beyond a hint that the discharge throw varies with the time of charging, although for short lengths this is not the case.

The best parts of the collection of "Notes and Forms" relate to electric light testing. The potentiometer is treated thoroughly, but we certainly miss the Carey-Foster method of comparing two nearly equal resistances. No doubt it would be said that at University College the place for the student to learn this is in Prof. Carey-Foster's laboratory, but, nevertheless, its omission might be rectified with advantage to those using the "Notes and Forms."

Tests on dynamos and motors are represented by the determination of the electrical efficiency of a small motor, efficiency of motor and of motor dynamo, of a pair of dynamos and of a gas engine and dynamo plant. The Brackett cradle and rope brake are introduced, while the student gets an idea of indicating gas engines, and the principle of electrical methods of dynamo testing, of the class devised by Hopkinson, Cardew, Ravenshaw, Rayleigh, and Swinburne. Alternating current work is not neglected, since forms with full instructions are provided for such investigations as efficiency tests of an alter-

nator and a transformer, the delineation of alternating current curves with Prof. Fleming's device, and work on alternating current instruments.

General instrument work is represented by the standardisation of an ammeter by copper deposition and of a high-tension voltmeter by comparison with a low pressure electrostatic instrument. It is here noted that two errors are to be avoided; one the contact error when using a multicellular on direct currents, and the other the capacity current when put on an alternating circuit. Alternating ammeters are calibrated by being put in series with instruments of the Weston or Kelvin balance type, which have been standardised by the potentiometer. Two important forms deal with the photometric examination of an arc lamp, and the complete efficiency test of a secondary battery. We recommend the latter to the perusal of those who intend to write reports on batteries submitted to their notice. It will help towards a general understanding of what a test should be, and we also hope Dr. Fleming's own tests will be made out on this form. Tests on iron are represented by a determination of the permeability of the hysteresis curves, and of the hysteretic loss. Altogether these notes are most satisfactory for advanced students, but they require to be supplemented for the junior class of work where they are even more necessary. As they can be bought singly for a few pence, they place within the reach of students the best information in skeleton form to enable any of the more common tests to be performed.

PROCEEDINGS OF SOCIETIES.

Physical Society.

Ordinary Meeting, June 28th, 1895.

Dr. Gladstone, vice-president, in the chair.

Mr. Bowden read a note on An Electro-Magnetic Effect.

A long glass tube containing mercury, and fitted with a small stand-pipe to indicate the hydrostatic pressure, is passed between the poles of an electro-magnet. On passing a current of about 30 ampères through the mercury in this tube, the stand pipe being turned so as to indicate the pressure either perpendicular or parallel to the lines of force of the field of the electro-magnet, movements of the mercury in the stand-pipe take place. When the stand-pipe is perpendicular to the lines of force of the field, the mercury rises or falls according to the direction of the current. When the stand-pipe, however, is parallel to the lines of force, the mercury always *rises*, whatever the direction of the current.

Prof. S. P. Thompson said there appeared to be three unexplained effects, one proportional to the current and the field, and reversible, another independent of the direction of the current or of the field, and a third which only occurred while the current was changing in strength. In addition, there may be a fourth effect, which up to now has not been noticed. The motion of the mercury column was in the opposite direction to that of the drag on a conductor carrying the current. An apparent rise in pressure might be due to a decrease in the density of the mercury, due to the heat developed by the current.

Mr. Blakesley asked if the author had noticed any changes in level in the mercury reservoirs at the ends of the tube.

The Author, in his reply, said the reservoirs at the ends were so large, that no changes of level were appreciable.

Mr. Rhodes read a paper on The Armature Reaction in a Single Phase Alternating Current Machine.

In this paper the author gives the investigations that were the subject of a verbal addendum to a paper read before the Society on a previous occasion. He investigates the lag or lead of the E.M.Fs. over the current, and applies the results to examine whether the field excitation of the generator or the motor is strengthened or weakened by the reaction of the armature currents.

Mr. De Tunzelmann expressed a hope that the author would amplify parts of his paper.

Mr. Blakesley said the conclusion of the author that "either of two alternate current machines may be driven as a motor by the other, irrespective of their relative E.M.Fs.," is not invariably correct. The facts of the case were these: The E.M.F. of the motor may exceed that of the other machine to a certain extent, but that E.M.F. multiplied by the cosine of the angle of electric lag must yield a product not greater than the E.M.F. of the generator, *i.e.*, using Mr. Rhodes's symbols, $e \cos \theta$, must not be greater than E. Mr. Blakesley gave a geometrical proof of this; but the same proposition had been given by him some ten years ago in the course of investigating the subject generally. This was at a time when Dr. John Hopkinson was, with less than his usual perspicuity, teaching that synchronous alternate current machines could not be run in series with stability, both doing work. Referring to the author's diagrams, Mr. Blakesley said that in a problem involving so many elements as that under consideration, it was impossible with the limited dimensions of space to represent the results with the complete generality of a formula. Some elements had to be taken as the independent, others as the dependent variables. The author had considered the power transmitted to the motor, the E.M.F. of the generator, and the angle of electric lag as independent. The E.M.F. of the motor was dependent. In Mr. Blakesley's original diagrams the E.M.Fs. were both considered independent, as well as the electric lag, and the powers applied or transmitted as dependent variables. In any case the formulæ properly derived from such diagrams became perfectly general, and it did not appear to him that the change of method indicated could properly be called a new theory on the subject. As a matter of fact diagrams based on the independence of the E.M.Fs. and the electric lag would furnish a better means of discussing the question of the stability of the motion than Mr. Rhodes's plan, and this might account for the entire omission from the paper of this important matter.

Prof. S. P. Thompson said it was impossible to discuss the question of stability till the subject of armature reaction had been thoroughly investigated. The terms lag and lead had been used by Mr. Rhodes in a consistent manner, but this was not always done, and he recommended that the phase of the current, which was common to both generator and motor, be taken as the standard. The author, in his reply, said he agreed with Mr. Blakesley that there was a limit to the extent to which the motor might be excited, and this upper limit could easily be obtained from the figure given in the paper. The question of armature reaction was, however, most important, as it might excite the field two or three times more than the original excitation, since motors were designed to do a certain amount of work, and not the work to fit the motor, it was most natural to take the output of the motor as fixed.

Mr. Shelford Bidwell read a paper on The Electrical Properties of Selenium.

The author has continued his investigations on this subject, and has come to the following conclusions:—1. The conductivity of crystalline selenium appears to depend principally on the impurities which it contains in the form of metallic selenides. It may be that the selenides conduct electrolytically, and that the influence of light in increasing the conductivity is to be attributed to its property of facilitating the combination of selenium with metals in contact with it. 2. A selenium cell having platinum electrodes and made with selenium to which about 3 per cent. of cuprous selenide has been added is, even though unannealed, greatly superior both in conductivity and sensitiveness to a similar cell made with ordinary selenium and annealed for several hours. 3. Red selenium in contact with copper or brass is quickly darkened by the action of light, owing, it is suggested, to the formation of a selenide. 4. Crystalline selenium is porous, and absorbs moisture from the air, and it is this moisture that causes the polarisation of selenium after the passage of a current. 5. The presence of moisture is not essential to sensitiveness, but appears to be in a slight degree favourable to it. 6. If cuprous selenide is made the cathode in an electrolytic cell, and a strip of platinum the anode in water, red selenium mixed with detached particles of the selenide is deposited in the water. 7. The photo-electric currents sometimes set up when light falls upon selenium are dependent upon the presence of moisture, and are no doubt of voltaic origin. 8. Perfectly dry selenium is below platinum in the thermo-electric series.

Prof. Minchin (communicated) suggested that the selenium cell "should be called a selenium resistance." A grid having one terminal made of aluminium and the other of copper might form a true cell, and might generate an E.M.F. when light fell on it. He (Prof. Minchin) would like to know if the author had tried any such cell in which light simply and solely generated an E.M.F. He could not agree that chemical action must necessarily follow the action of light in a cell. For take the case of the oldest photo-electric cell—the thermopile—what chemical action can we show here for all the energy of the incident heat? Chemical action due to light may or may not occur according to the nature of the cell.

Mr. Appleyard asked whether the author had submitted these selenium resistances to the action of electric oscillations. Prof. Minchin's "impulsion" cells were greatly influenced by electric oscillations. The great variation in the resistance with time of the author's cells pointed rather to an effect of contact between the selenium and the electrodes than to an elementary change in the structure or composition. He (Mr. Appleyard) had recently tried to crystallise a supersaturated solution of sodium sulphate by electric oscillations, as well as by direct sparks and by currents of several ampères, but no crystals could be induced to form. Change of contact, rather than change of structure, appeared to him to be the most promising direction in which to look for an adequate theory of selenium resistances.

Prof. Ramsey said the quantity of selenium liberated in the electrolytic experiment was much too great to be accounted for by oxygen dissolved in the water. The study of selenium was very interesting, for this substance was on the borderland between those bodies in which the electric conduction was metallic, and those in which it was known to be electrolytic.

The Author, in his reply, said he agreed that the name "selenium cell" was not an appropriate one. He had not tried the effect of electric oscillations.

The Society then adjourned till the autumn.

NEW PATENTS—1895.

12,187. "Improvements in telephonic apparatus." H. C. L. HOLDEN. Dated June 24th.

12,229. "Improvements in electric resistances and in the manufacture thereof." H. J. F. VOIGT and J. A. HAEFFNER. Dated June 24th.

12,232. "Improvements in or appertaining to the manufacture of electric cables and of materials therefor." J. B. ATHERTON and G. H. NISBETT. Dated June 24th.

12,244. "Improvements in electro-deposition." J. C. GRAHAM. Dated June 24th.

12,283. "Improvements in devices for attaching electric conductors to their supports." A. J. BOULT. (Communicated by L. K. Kugler, Germany.) Dated June 25th.

12,301. "Improvements in dynamos, motors, and alternators." L. B. ATKINSON. Dated June 25th.

12,311. "Improvements in contact or collector bars for the overhead conductors of electrical railways and tramways." SIEMENS BROS. & Co., LTD. (Communicated by Messrs. Siemens & Halske, Germany.) Dated June 25th.

12,320. "Process for preventing the chemical action of acids and other corrosive liquids on metal containers, conduits, and the like." C. A. JENSEN. (Communicated by A. Sinding-Larsen, Norway.) Dated June 25th. (*Complete.*)

12,329. "Improvements in and relating to telegraphic systems and instruments therefor." A. MERREL and A. DUFFEK. Dated June 25th. (*Complete.*)

12,374. "Improved means for indicating and controlling the supply of electricity to portable and other electric lamps and apparatus." R. HACKING and G. BRAND. Dated June 26th.

12,394. "A new or improved apparatus for indicating the time and number of telephonic communications." E. KOSANKE, C. FUHR, and B. KRAUSSE. Dated June 26th.

12,404. "Improvements in electricity meters." G. HOOKHAM. Dated June 26th.

12,412. "A combined heat radiator and electric lamp shade." A. L. TAYLOR. Dated June 27th.

12,414. "Improvements in apparatus for electrically lighting vehicles." J. T. NIBLETT. Dated June 27th.

12,417. "Improvements in the manufacture of positive plates for secondary electrical batteries." C. H. WEISE. Dated June 27th. (*Complete.*)

12,420. "Improvements in the manufacture of plates for secondary electrical batteries." C. H. WEISE. Dated June 27th. (*Complete.*)

12,438. "Ventilators for culverts, tubes, pipes, boxes, and chambers laid or fixed in roads and footpaths in connection with the distribution of electricity." W. WEAVER. Dated June 27th.

12,468. "Improvements relating to the current supply of electric railways by an auxiliary accumulator battery." A. MULLER. Dated June 27th. (*Complete.*)

12,469. "Improvements relating to electric railway vehicles." A. MULLER. Dated June 27th. (*Complete.*)

12,477. "Improvements in and connected with the insulation of storage cells, batteries, &c." K. J. TARRANT and C. R. G. SMYTHE. Dated June 28th.

12,499. "Improvements in holders for electric lamps." E. A. BROWNING. Dated June 28th.

12,521. "Improvements in and connected with the electrolysis of oxides, salts, and other compounds." J. B. TORRES. Dated June 28th.

12,533. "Improvements in electrical alarm devices for steam and other gauges." H. H. LAKE. (Communicated by W. H. Bradt and M. Marble, United States.) Dated June 28th. (*Complete.*)

12,545. "An electrically protected locking or fastening device for doors or the like." A. MOULART. Dated June 28th. (*Complete.*)

12,546. "Improvements in electricity meters." CHAMBERLAIN AND HOOKHAM, LTD., and S. H. HOLDEN. Dated June 28th.

12,596. "Improvements in apparatus for automatically governing electric transformers." A. G. NEW and A. J. MAYNE. Dated June 29th.

12,613. "Improvements in or connected with electric railways or electric transport." J. G. LORRAIN. (Communicated by F. C. Esmond, United States.) Dated June 29th.

12,614. "Improvements in or connected with electric railways or electric transport." J. G. LORRAIN. (Communicated by F. C. Esmond, United States.) Dated June 29th.

12,615. "Improvements in or connected with electric railways or electric transport." J. G. LORRAIN. (Communicated by F. C. Esmond, United States.) Dated June 29th.

12,616. "Improvements in or connected with electric railways or electric transport." J. G. LORRAIN. (Communicated by F. C. Esmond, United States.) Dated June 29th.

12,617. "Improvements in or connected with electric railways or electric transport." J. G. LORRAIN. (Communicated by F. C. Esmond, United States.) Dated June 29th.

12,622. "Improvements in secondary or accumulator cells." A. MULLER. Dated June 29th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1894.

8,480. "Improvements in and relating to galvanic batteries." T. H. RUSHTON. Dated April 28th. Claims:—1. A galvanic battery having negative elements placed in a slanting or oblique position, and positive elements adapted to turn on pivots, substantially as described. 2. In a galvanic battery pivoting the positive elements so that they can be raised out of the solution, or immersed more or less therein by turning them on their pivots, substantially as described. 3. In a galvanic battery having pivoted positive elements, connecting such elements with a main conductor by means of arms, cranks, or other suitable devices, kept in electric contact with such main conductor by the preponderating weight of the element itself, substantially as described. 4. A galvanic battery constructed and arranged substantially as described with reference to the drawings.

8,813. "Improvements in electric conductors." SIEMENS BROS. AND Co., LTD., and W. DIESELHORST. Dated May 3rd. Claim:—An electric conductor having its conducting metal insulated by helically coiling on it strips of insulating compound, and covering the same with lead.

11,069. "Improvements relating to the transmission of signals through submarine telegraph cables." A. MUIRHEAD. Dated June 7th. Relates to improvements in the mode of automatically making and breaking the contacts between line, earth and battery in the transmission of electric impulses or currents on submarine cables. 11 claims.

14,246. "An improved system of electrical distribution by alternating currents." C. F. SCOTT. (Under International Convention.) Dated February 26th. In a system of electrical distribution according to this invention, currents of different numbers of phases are employed, and the invention involves a novel method of and apparatus for accomplishing the change from one number of phases to another number of phases. The object being the transmission of electric currents by the number of phases which best secures the highest economy and convenience, this involves change to this number of phases from the number generated at the source of current, or change from the number used in transmission to the number desired for translating devices, or both changes. 4 claims.

16,887. "Improvements in or connected with ships' telegraphic apparatus." H. OLIVER. Dated September 5th. According to this invention, "tell-tale" telegraphic actions are automatically transmitted to the transmitting instrument on the bridge—or similar post or position, or to a separate instrument thereon, by which the different rates and directions at which the engine is set to go by the engineer or attendant, is ascertained and indicated. 4 claims.

17,525. "Improvements in laying electric conductors and in forming branch connections therefrom." J. A. JECKELL. Dated September 14th. The severed ends of pipes are fitted with annular plugs or ferrules around the main cable made of wood or other insulating material in halves. The necessary connections from the main electrical conductor to the branch conductors are made by means of metallic couplings so put together as to be very readily fitted upon the cables. A cast-iron casing, forming the junction box, made in halves, is then bolted around the pipe and branch cable where used so as to enclose the whole of the connections, and the upper half being lifted, to give complete access to the interior. 2 claims.

7,240. "Improvements in electrically-propelled common road vehicles." W. C. BERSEY. Dated April 11th. Between the wheel axles and the body of the vehicle a main frame is interposed, to which frame the electric motors, accumulators, or batteries, steering gear, and all appliances necessary for the electric propulsion of the vehicle are secured, the steering gear switches, and brake operating handles being arranged in front of the driver's seat, which is situated at the front part of said frame. This frame, or bogie, is entirely independent of the vehicle body, which is hung on the frame by springs or otherwise attached thereto. The axle of the hind wheels is fixed rigidly to the frame, or through the interposition of springs, whilst the front wheel axle is mounted in a swivelling under carriage with a turning plate operated by the steering gear from the driver's seat. A small well is constructed in the main frame, into which the accumulators are slid from the back of the vehicle, the axle being cranked to accommodate the well, or the accumulators may be suspended in a suitable box by springs or otherwise, if a straight axle be used. 1 claim.

7,801. "Improvements in or relating to electrolytical apparatus." C. KELLNER. Dated April 19th. Claim:—In apparatus for the electrolytical decomposition of alkaline salts a diaphragm or diaphragms of soap, or of soap provided with a supporting medium of material not materially affected by the products of decomposition formed in the course of the electrolytical process.

23,944. "Improved means for supplying electricity to electrically-propelled railway and tramway vehicles." A. DIATTO. Dated December 8th. Has reference to apparatus of the kind in which each vehicle to be propelled is equipped with means for receiving the electric current, by means of magnetic induction, from an underground conductor or conductors, by sliding over suitably insulated contact pieces located at suitable intervals over a subway, and, preferably, extending slightly above the surrounding surface of the ground, these contact pieces being adapted through the medium of suitable circuit closing devices beneath the same, and within the subway, to be placed in communication with an electric conductor in the subway simultaneously with the passage of the vehicle over the said contact pieces, the said circuit closing devices being enclosed within a casing constituting a part of the subway. 3 claims.